ChemTec™ Operations Manual

ChemTec Applications:

Bioreactor / Fermentor
Programmable Mass Flow Metering
Programmable Volume Flow Metering

Diafiltration Metering

pH Maintenance / Titration

Rev E2B, 12/09, Firmware Version 0.20F, P/N 300-030

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WARRANTY POLICY, PRODUCT RETURNS, ACCEPTABLE USE, AND OTHER RESTRICTIONS

1. WARRANTY AND RETURNS POLICY:

SCILOG, INC. EXPRESSLY WARRANTS THE EQUIPMENT MANUFACTURED BY IT ONLY AS SET FORTH HEREIN. SCILOG, INC. MAKES NO OTHER WARRANTIES, EITHER EXPRESS OR IMPLIED (INCLUDING WITHOUT LIMITATION WARRANTIES AS TO MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE). IN ADDITION, THE FOLLOWING SHALL CONSTITUTE THE SOLE AND EXCLUSIVE REMEDIES OF BUYER FOR ANY BREACH BY SCILOG, INC. OF ITS WARRANTY HEREUNDER.

A. PRODUCT WARRANTY – SciLog, Inc. warrants products it manufactures against defects in materials and workmanship for one (1) year from the date of shipment from SciLog, Inc. in normal use and service. If any products fail to conform to this warranty within the first ninety (90) days of the warranty period, SciLog, Inc. will, at its option, repair or replace such goods returned. If any products fail to conform to this warranty for the remainder of the warranty period, SciLog, Inc. shall furnish necessary replacement parts free of charge.

B. PARTS WARRANTY - SciLog, Inc. warrants service parts against defects in materials and workmanship for ninety (90) days from the date of shipment from SciLog, Inc. in normal use and service. If any service parts fail to conform to this warranty, SciLog, Inc. shall furnish necessary replacement parts free of charge.

C. WARRANTY LIMITATIONS - These warranties are subject to the following conditions:

1. Upon discovery of such non-conformity, SciLog, Inc. will be given prompt written notice with a detailed explanation of the alleged deficiencies.

2. The product or part must be properly installed, operated and maintained in accordance with SciLog, Inc. specifications.

3. The product or part must not be operated above rated load capacity or subject to accident, alteration, misuse, or abuse.

4. The product must not have been repaired or serviced by anyone other than SciLog, Inc. or one of its authorized dealers.

5. SciLog, Inc. shall have a reasonable time to repair or replace the effective product.

6. The buyer is responsible for shipping the product to SciLog, Inc. SciLog, Inc. is responsible for shipping the product back to the buyer.

D. RETURN POLICY - Any item may be returned within thirty (30) days from the date of shipment from SciLog, Inc. If the box is unopened (the original factory seal is intact), SciLog, Inc. will refund the full credit to the buyer. If the box is opened (the original factory seal is not intact), SciLog, Inc. will refund the full credit less a $75 inspection fee and repair labor/parts/materials cost (if applicable) to the buyer. No returns will be accepted after thirty (30) days from the date of shipment from SciLog, Inc. The buyer is responsible for shipping the product to SciLog, Inc.

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The sale and delivery of the SciLog, Inc.'s equipment and/or software to Buyer shall in no way transfer to Buyer any right of ownership in any patents, copyrights, trademarks, technologies, designs, specifications, drawings, or other intellectual property incorporated into the equipment and/or software.

3. DISCLAIMER OF DAMAGES

IN NO EVENT SHALL SCILOG, INC. BE LIABLE FOR ANY TYPE OF SPECIAL CONSEQUENTIAL, INDIRECT, INCIDENTAL OR PENAL DAMAGES, WHETHER SUCH DAMAGES ARISE OUT OF OR ARE A RESULT OF BREACH OF CONTRACT, WARRANTY, TORT (INCLUDING NEGLIGENCE), STRICT LIABILITY OR OTHERWISE. Such damages shall include but not be limited to loss of profits or revenues, loss of use of the equipment or associated equipment, cost of substitute equipment, facilities, down time costs, increased construction costs or claims of Buyer's customers or contractors for such damages. Buyer agrees that in the event of a transfer, assignment, or lease of the equipment sold hereunder Buyer shall secure for the SciLog, Inc. the protection afforded to it in this paragraph.

4. LIMITATION OF LIABILITY

The SciLog, Inc. shall not be liable for any loss, claim, expense or damage caused by, contributed to or arising out of the acts or omissions of Buyer or third parties, whether negligent or otherwise. In no event shall the SciLog, Inc.'s liability for any cause of action whatsoever exceed the cost of the item giving rise to the claim, whether based in contract, warranty, indemnity, or tort (including negligence). Any suit arising hereunder must be commenced within one (1) year from the date in which the cause of action accrues. Except as provided in Article 3, the SciLog, Inc. shall not indemnify any party.

5. NO RESPONSIBILITY FOR GRATUITOUS INFORMATION OR ASSISTANCE

If SciLog, Inc. provides Buyer with assistance or advice which concerns any parts, products, service supplied hereunder or any system or equipment in which any such part, product or service may be installed and which is not required pursuant hereto, the furnishing of such assistance or advice shall not subject SciLog, Inc. to any liability, whether based in contract warranty, tort (including negligence) or otherwise.

6. INTERNATIONAL SALES EXPORT

Buyer EXPRESSLY agrees and verifies that the purchased product(s) will not be transferred or exported to third parties or foreign nationals and that Buyer is the final end-user of the product. Export or transfer of any SciLog product without the EXPRESS written authorization of the SciLog, Inc. is strictly prohibited and may violate US trade laws and regulations, thereby subjecting the Buyer to civil and criminal liability.

7. REVISIONS TO THIS POLICY

From time to time the Company may revise the terms of this Agreement. Company will make its best efforts to inform customers of these revisions. The most current revision of these terms may be accessed over the internet by accessing the webpage located at: http://www.scilog.com/warranty

REGISTER YOUR PRODUCT(S) WITH SCILOG, INC. IMMEDIATELY AT:
http://www.scilog.com/register

Intelligent BioProcessing Systems
Phone: 608-824-0500 Fax: 608-824-0509
8845 South Greenview Drive, Suite 4
Middleton, Wisconsin 53562 USA

Intelligent BioProcessing Systems

Precautions:

READ this manual BEFORE operating or servicing this equipment.

FOLLOW these instructions carefully.

SAVE this manual for future reference.

DO NOT allow untrained personnel to operate, clean, inspect, service or tamper with this equipment.

ALWAYS DISCONNECT this equipment from the power source before cleaning or performing maintenance.

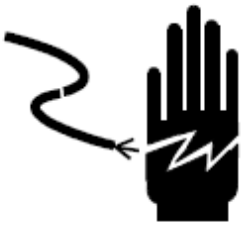
CALL SCILOG for parts, information and service.

WARNING

DISCONNECT ALL POWER TO THIS UNIT BEFORE INSTALLING, SERVICING, CLEANING, OR REMOVING THE FUSE. FAILURE TO DO SO COULD RESULT IN BODILY HARM AND/OR PROPERTY DAMAGE.

CAUTION

OBSERVE PRECAUTIONS FOR HANDLING ELECTROSTATIC SENSITIVE DEVICES.



WARNING

ONLY PERMIT QUALIFIED PERSONNEL TO SERVICE THIS EQUIPMENT. EXERCISE CARE WHEN MAKING CHECKS, TESTS AND ADJUSTMENTS THAT MUST BE MADE WITH POWER ON. FAILING TO OBSERVE THESE PRECAUTIONS CAN RESULT IN BODILY HARM.

WARNING

FOR CONTINUED PROTECTION AGAINST SHOCK HAZARD, CONNECT TO PROPERLY GROUNDED OUTLET ONLY. DO NOT REMOVE THE GROUND PRONG.

PRÉCAUTIONS:

LISEZ ce manuel AVANT de faire fonctionner ou d'entretenir cet équipement.

SUIVEZ attentivement ces instructions.

CONSERVEZ ce manuel pour future référence.

NE LAISSEZ PAS du personnel non qualifié utiliser, nettoyer, inspecter, entretenir, réparer ou manipuler cet équipement.

DÉBRANCHEZ TOUJOURS cet équipement de la source de courant avant de nettoyer ou d'exécuter l'entretien.

APPELEZ SCILOG pour pièces détachées, renseignements et entretien.

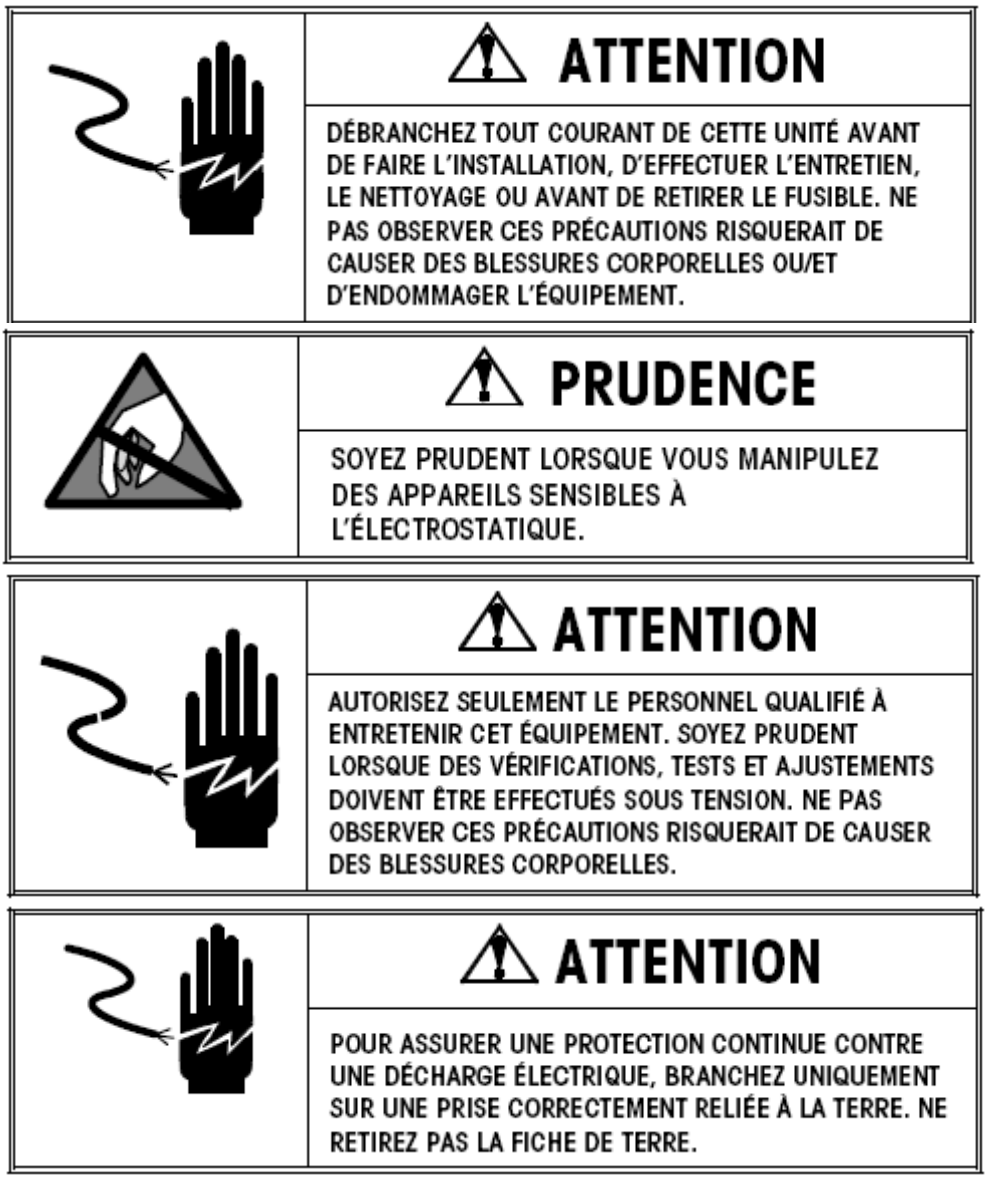


Table of Contents

Standards:

The ChemTec™ conforms to the following standards:

EN 61326-1:2006, Class B
EN 6100-3-2:2006
EN 6100-3-3:1995 +A1:2001 +A2:2006
EN 61010-1 Issued: 2001/03/01
UL 61010-1 Issued: 2004/07/12 Ed.2
And is certified to: CAN/CSA-C22.2 No 61010-1 Ed.2

Installation & Start-Up:

Installation of the ChemTec™ System must be carried out only by trained personnel in accordance with the relevant regulations and this operations manual.

Make sure that the technical specifications and input ratings of the ChemTec™ are observed. See “ChemTec™ Specifications”.

The protection provided by this equipment may be impaired if the ChemTec™ is used in a manner inconsistent with this manual or for purposes not specified by the manufacturer.

Maintenance & Cleaning:

The ChemTec™ is practically maintenance free. The SciPres™ disposable sensors used with the system come pre-calibrated from the factory and require no maintenance. The Tandem™ peristaltic pump head should periodically have tubing debris cleaned from it, but requires no lubrication.

To remove dust, dirt and stains, the outer surfaces of the ChemTec™ may be wiped using a soft, non-fluffing cloth moistened with water. If required, you may also use a mild detergent or 2-propanol.

The SciPres™ disposable sensors may be sanitized with 0.1 Molar NaOH, or 2-propanol. They may be autoclaved up to twice, and newer units with grey rings around the cable connector may be gamma irradiated.

Introduction:

You will find the ChemTec™ System easy to use. The state-of-the-art hardware and software design of the ChemTec™ allows you to control measure and document your filtration processes. With proper maintenance, the ChemTec™ System will provide many years of excellent service and performance.

Please read the following instructions carefully!

Inspections: Unpack the ChemTec and accessories carefully from the carton. Cross-check the contents against your purchase order to verify that all parts are included and undamaged.

Please do the inspection now, even if the ChemTec is not used immediately. Many carriers must receive damage claims within seven days of delivery. Please retain all packing material so unit may be shipped safely, if necessary.

SciLog Customer Service:
If you need assistance, please call: **1-800-955-1993** or **1-608 –824-0500**

SciLog Customer Service personnel will be able to serve you more efficiently if you have the following information:

- Serial number (back panel) and model name of the equipment.
- Installation procedure you used.
- Concise list of symptoms.
- List of operating procedures and conditions you were using when problem arose.

Warranty Repair: Units covered under warranty will be repaired and returned to you at no charge. If you have any questions about applicability, please contact SciLog.

Non-warranty Repair: For out-of-warranty repair, contact the SciLog Customer Service Department. A SciLog representative will discuss service options with you and can assist in making arrangements to return the equipment, if necessary.

Repair Procedure: Before returning any SciLog equipment for repair or service, contact SciLog to obtain an RGA Number. To return a piece of equipment:

Carefully pack the unit to prevent damage in transit. Check with SciLog regarding the proper method of shipment. No responsibility is assumed by SciLog for damage caused by improperly packaged instruments. Indicate the RGA Number on the carton and on the packing slip. Always insure for the replacement value of the unit.

Include a description of the symptoms, your name, return address, phone number, RGA number and purchase order to cover repair costs, return and shipping charges, if your institution requires it. Ship to:

SciLog Inc.
8845 S. Greenview Drive.; Suite 4
Middleton, WI 53562-2562

ChemTec Maintenance

A factory cleaning, testing and recalibration should be performed to your ChemTec at least once a year.

Fill Out this Form & Fax it to SciLog at FAX: 608-824-0509.

SciLog will send you a **loaner pump for one week** if you request it. **$350/week**
This price includes the cost of next day shipping & insurance to send the loaner to you.

Use the packing material from the loaner & send your pump to:

SciLog Inc.
8845 S. Greenview Dr, Suite 4
Middleton, WI, 53562

SciLog will disassemble, clean and lubricate the pump head, **$350**
change the seals if appropriate, test, recalibrate and generate a Performance Validation for your ChemTec. If your pump needs a new motor or pump head, then we will contact you & get your approval before replacing them. A new motor is $425; a new piston head is $695; a new peristaltic Tandem head is $255. Most of the time, cleaning and recalibration is all that is needed to insure many years of service. Price includes the cost of SciLog shipping your pump back.

Once you receive your cleaned/repaired ChemTec, use the packing material to repack the loaner and send it back to SciLog.

Assuming no replacement parts are required,
Total Cost, including Loaner and Shipping: **$700**

Please Check all of the following that are appropriate:
___ Yes, I need my ChemTec cleaned and recalibrated.
___ Yes, I need a loaner ChemTec sent to me.

PO# _____ or Credit Card# _____
Credit Card Expiration Date _____

Send the Loaner and/or Repaired / Cleaned ChemTec to:
Company: _____
Address: _____
_____
Contact: _____
Contact Phone #: _____
Contact Fax #: _____
Contact Email: _____

Call SciLog Customer Service at 800-955-1993 with any questions.

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ChemTec System Specifications:

Mechanical:

- **Dimensions:** Width: 5.75 in (14.6cm); Height: 8.5 in (212.6); Depth: 11in (27.9)
- **Weight:** 14 lbs (6.4kg)
- **Enclosure:** Aluminum / Steel; Corrosion Resistant, Recessible Handle
- **Accommodates a range of motor / pump heads combinations, including:**
  - **Peristaltic pump heads**, TANDEM model 1081 and 1082, either with 8, 160, or 600 RPM motors.
  - **Piston pump heads**, FMI model RH1, RH0 or RH00, either with 160, 600 or 3400 RPM motors.
  - **Magnetic gear pump heads**, Micropump models 040, 120, 184, 187, 200 & 201, with 3400 RPM motors.
- **Pressure Sensors:** Accommodates one SciPres ™ Disposable pressure sensor using the P1 Port. P2 and P3 ports may be used as alternates. Pressure is used for monitoring and alarms. The user selects P1, P2 or P3 as the pressure source.
- **Pressure Displayed** with a resolution of 0.1 psi; choice of **bar, psi, kpa**.
- **Pressure Range:** The default pressure range of the sensors is **0-60psi**, and is calibrated at the factory. Most peristaltic pumps generate pressures up to 40 psi. If you have need for higher pressures, contact SciLog Customer Service for assistance.

Electrical:

- **Power:** 90 - 264 V~, 47-63 Hz, 75 VA, listed Class 2 switching power supply; double fused: 1A-T, 250V (CE: IR35A 250V~).
- **Operational Range:** 4 to 40° C.
- **Motor:** Choice of four motors: 8, 160, 600 and 3400 RPM at 24V ⎓, 3.8 Amperes, Variable Pump Speed optically encoded, servo-controlled motors.
- **Encoder:** 100 lines/rev. for 600-RPM motor. 120 lines per/rev. for all other motors.
- **I/O Ports:**
  - "**Printer**", Female DB9 connector for data collection with Printer or PC.
  - "**S1**", Male DB9 connector for RS-232 connection to an electronic scale.
  - "**S2**", Male DB9 connector, Not utilized on ChemTec. Do not remove the cover.
  - "**S3**", Male DB9 connector, Not utilized on ChemTec. Do not remove the cover.
  - "**External I/O**", Female DB37 connector used for remote On/Off control of ChemTec via footswitch, or for Analog interface with 4-20 ma sources, A1, A2, A3.
  - "**V**", Female DB15 connector. Used for control of 6-way stream selection valve.
  - "**Temperature**", 2 pin Conxall connector for SciTemp™ disposable Temperature Sensor.
  - "**P1, P2, P3**", RJ11 connectors used for SciPres disposable Pressure Sensors.
  - "**USB**", USB-A connector, used for RS-232 data collection with a PC.
  - "**Ethernet**", RJ-45 connector, used for Modbus TCP/IP connection with system. (when available)
- **Display:** Two line LCD, 20 characters each, back-lit.
- **Data Entry**: Membrane keyboard with auditory feedback.

ChemTec Software:

Main menu with the following six operational modes:

- **Mass Flow Mode:** Programmable gravimetric metering, which requires an electronic balance.
- **Volume Flow Mode:** Programmable volumetric metering.
- **Perfusion Mode:** Maintains weight of Reaction vessel, and requires an electronic balance. Can be additive or subtractive.
- **pH Control:** Provides control of pH Maintenance and/or End Point Titration via connection to pH meter with 4-20 ma output.
- **Analog:** Provides direct proportional control of motor speed based upon an external 4-20 mA signal.
- **Manual:** Simple pump control; no alarms.
- **Setup:** Selection of user preferences and interface options.

Documentation Software for PC:

SciDoc Excel Spreadsheet with custom macros and WinWedge interface software for data compilation. Sent to you ready to use.

- Complete process analysis with graphing of data.
- Real-time verification and documentation of process parameters.
- Includes graph of:
    - Pump Rate (PR) and Pressure (P1) vs. Time
    - Additional graphs can be made by the end user.

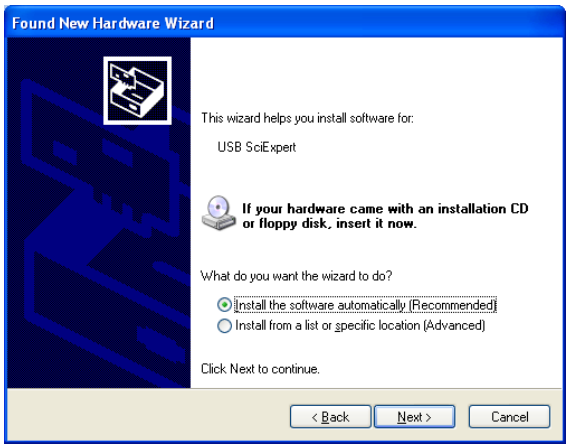
Display, Print out and Excel Abbreviations:

MT = Military Time, HH:MM:SS
RT = Run Time, 00:00:00 at START
CW = Cumulative Weight, gm
P1 = Pressure at Sensor 1, psi, bar or kpa
P2 = Pressure at Sensor 2, psi, bar or kpa
P3 = Pressure at Sensor 3, psi, bar or kpa
AL = Alarm, e.g. CV Cumulative Volume Alarm
HP=4, High Pressure Alarm is “Pmaintain”
LP=1, Low Pressure Alarm is “OFF”
PR=3, Pump Rate Alarm is “PUMP STOP”
T = Temperature, ºC
A2 = Analog Signal 2

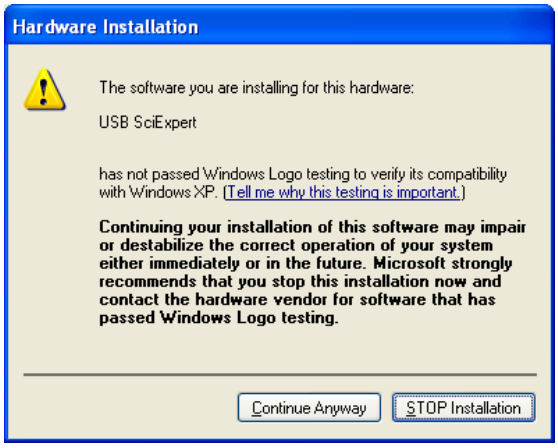
PR = Pump Rate, ml/min
CV = Cumulative Volume, ml
C1 = Collection Rate, gr/min
CW = Clockwise Pump Direction
CCW =Counter Clockwise Pump Direction
ST = Pump Status, START, RUN, etc.
CV=1, Cumulative Volume Alarm is “OFF”
EP=2, End of Program Alarm is “ALERT ONLY”
VP = Valve “V” Position
WP = Valve “W” Position
A1 = Analog Signal 1
A3 = Analog Signal 3

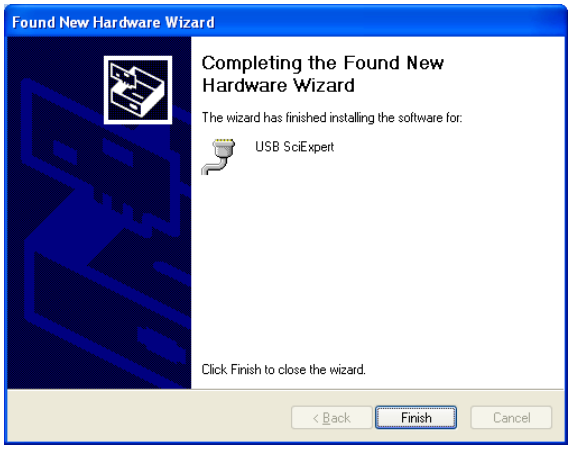
Installation of the USB Driver:

Upon connecting the ChemTec to the PC via a USB cable, the following “New Hardware Wizard” window appears. Select ‘No, not at this time” and click “Next”. The second screen appears:



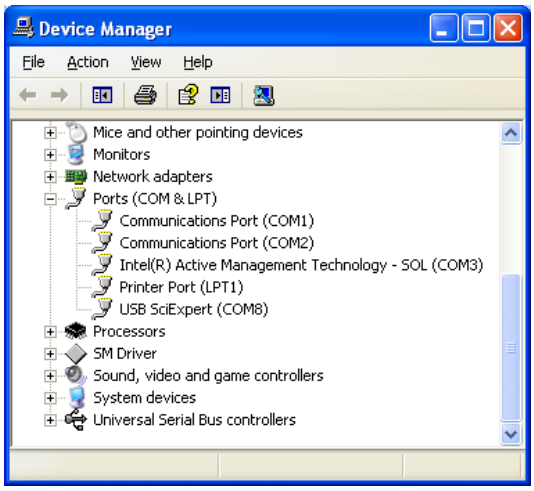
Insert the CD containing the ChemTec Operating Manual into the PC, choose “Install the software automatically” and click “Next”. The following screen appears:





Choose “Continue Anyway”, and the driver will finish loading, allowing you to communicate to the ChemTec via the assigned Com Port.

By opening Windows Device Manager and clicking on the + for Ports, you can determine the Com Port assigned to the ChemTec. It will be listed as “USB SciExpert”. (COM8 as shown)



SciLog
Intelligent BioProcessing Systems

Start-up: “Volume Flow Metering into a Bioreactor or Fermentor”

Equipment: The following items are needed to get started:

SciLog P/N	Description	Quantity
200-CHEM-1181	ChemTec, CP-120 w/ 1081 Tandem Peristaltic Head, 160rpm Motor	1 pc
400-116	Silicone Tubing, Platinum Cured, #16	25 ft (1 pkg)
080-095A	Printer Kit, includes Printer, Cable, 6 rolls Paper	1 kit
	Appropriate Media Reservoir	1 pc
	Appropriate Bioreactor or Fermentor	1 pc

Hardware Setup:

1. Unpack all the components, visually identify and inspect for damage.
2. At the Reaction bench, place the Media reservoir to the far left. Moving to the right on the bench, place the ChemTec, and then the Bioreactor or Fermentor. Leave some space between these items to allow for cables and tubing.
3. Connect the printer interface cable between the rear of the printer and the “Printer” connector on the rear of the ChemTec. This cable does not have its ends labeled, as it is the same on both ends and may be reversed. Place the printer in a convenient location.
4. Plug in and power-up all the equipment.
5. Cut approx. 6-8 ft. of the #16 tubing and connect it to the Media reservoir. Route the tubing from the reservoir to the ChemTec, open the head by rotating the lever 180 degrees counter-clockwise, and place the tubing over the upper set of rollers. Confirm that the tubing is under the centering springs and close the head by rotating the lever back to its original position. Connect the remaining end to the Bioreactor or Fermentor. This completes the hardware and tubing configuration.

Program Editing and Execution:

At this point, please consider the parameters of the reaction being fed and determine if the type of metering that is needed. This can be done at a constant rate, a linear rate, or an exponential rate. Several user-definable alarms may be utilized to monitor the process; the pumping rate, the cumulative volume, the measured pressure, and when the end of the program has been achieved. All the alarms may be set to “**Off**” (disabled), “**Beep Only**” (an audible alarm), and “**Pump Stop**” (stops the pump and sounds the audible alarm).

Volume Flow: Setup:

Press the “**EXIT**” button several times to reach the top of the menu:

Mode Selct		MASS FLOW
Up	Down	Select
A	B	C

Press “**A**” to scroll up until the following appears:

Mode Selct		VOLU FLOW
Up	Down	Select
A	B	C

Press “**C**” to Select, and this screen now appears:

- VOLU FLOW -		
Exec	Edit	Setup
A	B	C

Pressing “**C**” for Setup gives provides access to the following parameters:

- **CUMULATIVE VOLUME:** Alarm will occur when a user-definable cumulative volume limit has been metered. Press “**C**” to Select, then use “**A**” and “**B**” to increase or decrease the amount, up to a total of 99,999 ml. (depending on the calibration curve), then press “**C**” to Select the amount. This sets the limit for the Volume Alarm below.
- **VOLUME ALARM:** Set the appropriate option for the above alarm limit, **OFF**, **Alarm Only**, or **Pump Stop**. Use “**Pump Stop**” if this is a critical alarm. Press “**C**” to select, “**A**” and “**B**” to scroll thru the selections, and “**C**” again to select.
- **END OF PROGRAM:** Set the appropriate alarm option to be alerted when the program has come to an end.
- **PRESSURE ZERO:** Used to “Zero” the signal from the SciPres disposable pressure sensors. Press “P1” and with no pressure in the system, press “Zero”. As there is a built in calibration curve for the sensors, this “zeroing” to remove any offset caused by the electronics or hydraulic pressure in the system is all that is needed.
- **CLEAR TOTALS:** Use this to clear the cumulative volume values.
- **PUMP TUBING:** Use this option to select the tubing in use. This will access the related internal calibration curve. This curve can be re-calibrated, see the Re-Cal section of this manual.

Volume Flow: Edit /Execute:

The ChemTec will dispense volumetrically over time intervals and at rates that are user specified in a program that is either generated from the front panel, or uploaded from a PC.

The ChemTec will only store one Volume Flow program at a time. When generating or editing a Volume Flow program, all program statements that are to be implemented during a specific timing block or interval must precede the TIME statement for that timing block.

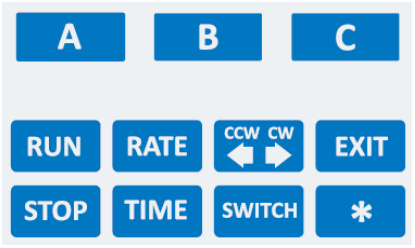
All programs contain a START statement, and an END statement that cannot be deleted. A simple Volume Flow program follows, and how the statements are implemented from the keypad is described.

From the earlier screen, press “**B**” to select Edit instead of Setup.

- VOLU FLOW -		
Exec	Edit	Setup
A	B	C

The following display is shown. The buttons on the keypad are represented.

000 START		000
Next	Delete	Last



On the display, the first set of **000**'s indicates the statement number, then the program statement , and the final set of **000**'s shows the number of statements in the existing program. The "**A**" key moves to the **Next** statement in the program, the "**B**" key will **Delete** the displayed statement, and the "**C**" key will moves to the previous (**Last**) statement in the program. In order to replace a statement with a different one, press "**B**" to **Delete** the incorrect statement, then press "**C**" to go back to the **Last** statement, and enter the new statement.

The keys input of the following program statements:

This key inputs a RUN statement, instructs the ChemTec to turn on the pump motor. It is also used to execute a program in response to the message "Press RUN when Ready" at the beginning of a run.

Press this key, and select the desired volume flow rate. Be sure the rate chosen does not exceed the rated capacity of the installed pump head/motor/tubing combination. Use the "**A**" and "**B**" keys to set the rate, and the "**C**" key to select it.

Press this key to define the direction of the pump. This acts as a toggle switch, and allows selection of either clock-wise (CW) or counter clock-wise (CCW).

This key exits the mode and brings the ChemTec up one menu level.

This key will input a STOP statement, and instruct the ChemTec to stop the pump motor. While the program is running, this key acts as an emergency stop button.

Use this key to input a TIME statement, use "**A**" and "**B**" keys to set the time in hours:minutes, and then the "**C**" key to select it. Put at the end of a programming block to indicate the length of time to execute the statements since the last TIME statement.

This enters a Sw BITS statement that allows programming of TTL switches 1-4 to provide automated control of external devices.

This key provides access to three other programming statements:

Interpolation Rate: Puts in a linearly ramped pump rate over time specified by a TIME statement. This is the final rate, and the initial rate is the previously programmed rate.
Rotary Valve: Allows programming of two 6-position valves, "V" and "W". The statement V1 would tell valve "V" to be in position #1.
Sample Count: Using this statement allows you to run the program repeatedly, up to 999 times. This only works at the end of a program, nested Counts aren't allowed.

For the purposes of this document, there is a bioreactor that needs to be feed a nutrient solution at the rate of 10ml/min for 2 hours, and then have that rate increase in a linear manner over the next 8 hours to 60 ml/min., continue at that rate for 2 more hours, and then stop. Here's the program to input into the ChemTec:

000	START
001	RUN
002	CW
003	RATE 10ml/min
004	TIME 02:00
005	INTRP 60ml/min
006	TIME 08:00
007	RATE 60ml/min
008	TIME 02:00
009	STOP
010	END

When finished entering the program, press **EXIT**, and then "**B**" for Edit again, and you will see the following screen:

000 START		009
Next	Delete	Last
A	B	C

Since the START and END statements cannot be entered manually, and can't be deleted either, they are not included in the line count shown here as 009, when one might think it should be 010 or 011. This represents the count of the lines that were actually entered.

After setting the above parameters, it's time to prime the ChemTec. Press the **EXIT** key on the front panel until the Mode Select screen is seen. From the Mode Select screen, use "**A**" or "**B**" to go up or down to the "MANUAL" mode. The following is displayed:

Mode Selct		MANUAL
Up	Down	Select
A	B	C

Press "**C**" to Select, and the screen will change to the following:

- MANUAL -	100.0%	
Sw=0000		CW
A	B	C

Press the "**RUN**" key and allow the ChemTec to run until all air is removed from the tubing between the Media Reservoir and the Bioreactor. Press the "**STOP**" key to stop the pump.

Pressing the "**EXIT**" key returns one to the Mode Select screen. Use the "**A**" and "**B**" buttons to scroll to the "VOLU FLOW" mode. Press "**C**" to Select it, and "**A**" to Execute and the following screen will be displayed:

VOLU FLOW	10.00ml/m
Press RUN when Ready	

When ready, Press the RUN key, and the following screen is displayed:

00:00:00			RUN
CV	0.0ml	PR	200.0
A	B		C

PR= Pump Rate (ml/minute), **CW**= Cumulative Volume, **00:00:00**= Relative (Run) Time (hrs:min:sec), **RUN** = Pump Status.

NOTE: The Cumulative Volume values will remain if the process is interrupted and restarted, whether it is via an alarm, or the use of the **STOP** or **EXIT** keys. The Clear Totals option in the Setup Menu, or when prompted after pressing "Exit" will allow you to reset these values.

This program demonstrates both a constant and linear feed rate. Refer to Section C of the ChemTec manual for additional examples of programs that generate exponential feeds, time delayed feeds, chromatography applications, and the use of the 6 position rotary valves.

Documentation:

The ChemTec outputs data to a printer or a PC at periodic user-definable intervals for archival purposes. The following is an example of that data:.

09/10/09; 09:59; CHEM 0.11X; Volume Flow; Tubing=15; Units=psi; VOLU-FLOW= 20.0 ml/m; Alarms; CV=1; EP=1; HP=1 Limits; CV= 0.0ml; HP=30.0

RT, CV, PR, VP, WP, P1, T, A1, A2, A3, ST,

00:00:00, 0, 20.0, 0, 0, 0.0, 24.2, 0, 0, 0, START
00:00:30, 10, 20.0, 0, 0, 0.0, 24.0, 0, 0, 0, RUN
00:01:00, 20, 20.0, 0, 0, 0.0, 23.9, 0, 0, 0, RUN
00:01:30, 30, 20.0, 0, 0, 0.0, 23.8, 0, 0, 0, RUN
00:02:00, 40, 20.0, 0, 0, 0.0, 23.6, 0, 0, 0, RUN
00:02:13, 44, 20.0, 0, 0, 0.0, 23.6, 0, 0, 0, PAUSE
00:02:13, 44, 20.0, 0, 0, 0.0, 23.6, 0, 0, 0, START
00:02:30, 50, 20.0, 0, 0, 0.0, 23.5, 0, 0, 0, RUN
00:02:32, 51, 20.0, 0, 0, 0.0, 23.5, 0, 0, 0, EXIT

RT = Relative (Run) Time, hh:mm:ss. (Will be MT, Military Time if system set for “Time of Day”)
CV = Cumulative Volume.
PR = Pump Rate, displays the pump rate at that moment in time.
VP = V Position, represents the position of Valve “V” (will be 0 if not in use, otherwise 1-6)
WP = W Position, represents the position of Valve “W” (will be 0 if not in use, otherwise 1-6)
ST = STATUS, Pump Status (Start, Run, Pause, Run, Exit)
AL = ALARM, Print out of Alarm condition. AL=PR represents Pump Rate Alarm, AL = CV represents Cumulative Volume Alarm, AL=EP represents End of Program Alarm.

NOTE: Three alarm levels are defined and displayed in the program header of the printout as follows: 1 = Off (Deactivated); 2 = Alarm Only (Metering continues, auditory beep/5V output to remote alarm occurs); 3 = Pump Stop (Stops the pump, auditory beep/5V output to remote alarm occurs). Immediate data printout occurs when RUN, STOP or EXIT keys are pressed, and when an alarm occurs. All other printouts occur at a user definable frequency in minutes: seconds (Mode: Setup, Printer, Time).

SciLog recommends a factory cleaning, testing and recalibration of the ChemTec at least once a year, to maintain the accuracy of the unit and reduce downtime. SciLog also has loaner units available to rent if you need to keep production running while SciLog is performing maintenance. Call SciLog at 800-955-1993 for an RGA and arrange for a loaner if needed.

The following chart shows tubing dimensions and the available flow rates based on tubing and motor size:

MasterFlex Tubing	13	14	16	25	17	18	15	24	35
Tubing ID*: in	0.030	0.060	0.125	0.190	0.250	0.310	0.190	0.250	0.310
Tubing OD*: in	0.157	0.189	0.251	0.314	0.376	0.439	0.376	0.439	0.500
Tubing Wall*: in	0.063	0.063	0.063	0.063	0.063	0.063	0.093	0.093	0.093
Pump Rate Range*:	ml/min	ml/min	ml/min	ml/min	ml/min	ml/min	ml/min	ml/min	ml/min
CP-8 8RPM	0.03 - 0.45	0.10 –1.63	0.43-6.38	0.9 - 12.6	1.14 -18.3	1.7 - 24.3	0.45 – 13	0.65 – 20	0.8 - 32
CP-120 160RPM	0.5 - 10	1.7 - 35.2	6.3 - 129	12.5 - 283	18.5 - 405	24.7 - 554	9 – 260	13 – 435	16 – 650
CP-200 600RPM	2 - 34	8.6- 132	29 - 533	49 -974	70 - 1048	103 - 1515	59-993	85-1348	111 - 2258
* Nominal Values									
Pump Head Model:	TANDEM 1081						TANDEM 1082		

Start-up: “Mass Flow Metering into a Bioreactor or Fermentor”

Equipment: You will need the following items to get started:

SciLog P/N	Description	Quantity
200-CHEM-1181	ChemTec, CP-120 w/ 1081 Tandem Peristaltic Head, 160rpm Motor	1 pc
100-VIPER6	Mettler Toledo BBA422 Scale, 6000gm x.1gm	1 pc
400-116	Silicone Tubing, Platinum Cured, #16	25 ft (1 pkg)
080-067PGS	Cable, Interfaces ChemTec and Mettler Scale	1pc
080-095A	Printer Kit, includes Printer, Cable, 6 rolls Paper	1 kit
	Appropriate Media Reservoir	1 pc
	Appropriate Bioreactor or Fermentor	1 pc

Hardware Setup:

1. Unpack all the components, visually identify and inspect for damage.
2. At the Reaction bench, place the Scale with the Media reservoir on it to the far left. Moving to the right on the bench, place the ChemTec, and then the Bioreactor or Fermentor. Leave some space between these items to allow for cables and tubing.
3. Connect the interface cable between the ChemTec and the scale paying close attention to the labels on the cable and those on the rear of the ChemTec. The “Pump” end of the cable is connected to the “S1” connector on the rear panel of the ChemTec. The “Balance” end of the cable plugs into the output connector on the rear of the scale.
4. Connect the printer interface cable between the rear of the printer and the “Printer” connector on the rear of the ChemTec. This cable does not have its ends labeled, as it is the same on both ends and may be reversed. Place the printer in a convenient location.
5. Plug in and power-up all the equipment.
6. If the ChemTec and Scale were purchased together from SciLog, both will be configured to communicate with each other. If purchased separately, contact SciLog Technical Customer Service for instructions.
7. Cut approx. 6-8 ft. of the #16 tubing and connect it to the Media reservoir. Route the tubing from the reservoir to the ChemTec, open the head by rotating the lever 180 degrees counter-clockwise, and place the tubing over the upper set of rollers. Confirm that the tubing is under the centering springs and close the head by rotating the lever back to its original position. Connect the remaining end to the Bioreactor or Fermentor. This completes the hardware and tubing configuration.

Program Editing and Execution:

At this point, please consider the parameters of the reaction being fed and determine if the type of metering that is needed. This can be done at a constant rate, a linear rate, or an exponential rate. Several user-definable alarms may be utilized to monitor the process; the pumping rate, the cumulative volume, the measured pressure, and when the end of the program has been achieved. All the alarms may be set to “**Off**” (disabled), “**Beep Only**” (an audible alarm), and “**Pump Stop**” (stops the pump and sounds the audible alarm).

Press the “**EXIT**” button several times to reach the top of the menu. This display is seen:

Mode Selct		MASS FLOW
Up	Down	Select
A	B	C

Press “**C**” to Select, and this screen now appears:

- MASS FLOW -		
Exec	Edit	Setup
A	B	C

Pressing “**C**” for Setup gives you access to the following parameters:

- **CUMULATIVE WEIGHT:** Alarm will occur when a user-definable cumulative weight limit has been metered. Press “**C**” to Select, then use “**A**” and “**B**” to increase or decrease the amount, up to a total of 9999.9 gm., then press “**C**” to Select the amount. This sets the limit for the Weight Alarm below.
- **WEIGHT ALARM:** Set the appropriate option for the above limit alarm, **OFF**, **Alarm Only**, or **Pump Stop**. Use “**Pump Stop**” if this is a critical alarm. Press “**C**” to select, “**A**” and “**B**” to scroll thru the selections, and “**C**” again to select.
- **END OF PROGRAM:** Set the appropriate alarm option to be alerted when the program has come to an end.
- **PUMP RATE:** This alarm will trigger when the selected pump rate cannot be maintained over any 60-second interval. This will occur if the reservoir has become empty, the system has sprung a leak, or if the pump rate selected is beyond the capacity of the pump head/tubing combination. The pump will ramp up to 100% of pump speed for 30 sec. before triggering the alarm. If this is a critical parameter, this alarm should be set to “**Pump Stop**”.
- **PRESSURE ZERO:** Used to “Zero” the signal from the SciPres disposable pressure sensors. Press “P1” and with no pressure in the system, press “Zero”. As there is a built in calibration curve for the sensors, this “zeroing” to remove any offset caused by the electronics or hydraulic pressure in the system is all that is needed.
- **CLEAR TOTALS:** Use this to clear the cumulative volume values.

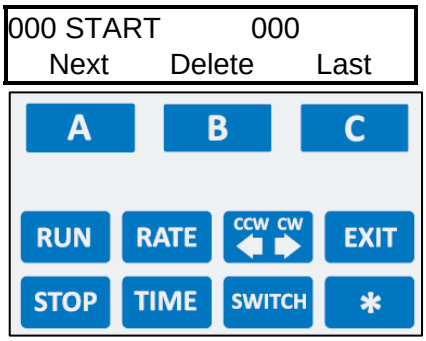
Mass Flow: Edit /Execute:

The ChemTec will dispense gravimetrically over time intervals and at rates that are user specified in a program that is either generated from the keypad, or uploaded from a PC.

The ChemTec will only store one Mass Flow program at a time. When generating or editing a Mass Flow program, all program statements that are to be implemented during a specific timing block or interval must precede the TIME statement for that timing block.

All programs contain a START statement, and an END statement that cannot be deleted. A simple Mass Flow program follows, and how the statements are implemented from the keypad.

From the earlier screen, press “**B**” to select Edit instead of Setup. The following display is shown. The buttons on the keypad are represented.



On the display, the first set of **000**'s indicates the statement number, and then the program statement, and the final set of **000**'s shows the number of statements in the existing program. The "**A**" key moves to the **Next** statement in the program, the "**B**" key will **Delete** the displayed statement, and the "**C**" key moves to the previous (**Last**) statement in the program. In order to replace a statement with a different one, press "**B**" to **Delete** the incorrect statement, then press "**C**" to go back to the **Last** statement, and enter the new statement.

The keys input the following program statements:

RUN This key inputs a RUN statement, instructs the ChemTec to turn on the pump motor. It is also used to execute a program in response to the message "Press RUN when Ready" at the beginning of a run.

RATE Press this key, and select the desired volume flow rate. Be sure the rate chosen does not exceed the rated capacity of the installed pump head/motor/tubing combination. Use the "**A**" and "**B**" keys to set the rate, and the "**C**" key to select it.

CCW CW Press this key to define the direction of the pump. This acts as a toggle switch, and allows selection of either clock-wise (CW) or counter clock-wise (CCW).

EXIT This key exits the mode and brings the ChemTec up one menu level.

STOP This key will input a STOP statement, and instruct the ChemTec to stop the pump motor. While the program is running, this key acts as an emergency stop button.

TIME Use this key to input a TIME statement, use "**A**" and "**B**" keys to set the time in hours:minutes, and then the "**C**" key to select it. Put at the end of a programming block to indicate the length of time to execute the statements since the last TIME statement.

SWITCH This enters a Sw BITS statement that allows programming of TTL switches 1-4 to provide automated control of external devices.

* This key provides access to three other programming statements:

Interpolation Rate: Puts in a linearly ramped pump rate over time specified by a TIME statement. This is the final rate, and the initial rate is the previously programmed rate.
Rotary Valve: Allows programming of two 6-position valves, "V" and "W". The statement V1 would tell valve "V" to be in position #1.
Sample Count: Using this statement allows you to run the program repeatedly, up to 999 times. This only works at the end of a program, nested Counts aren't allowed.

For the purposes of this document, there is a bioreactor that needs to be feed a nutrient solution at the rate of 10gm/min for 2 hours, and then have that rate increase in a linear manner over the next 8 hours to 50 gm/min., continue at that rate for 2 more hours, and then stop. Here's the program to input into the ChemTec:

000	START
001	RUN
002	CW
003	RATE 10gm/min
004	TIME 02:00
005	INTRP 50 gm/min
006	TIME 08:00
007	RATE 50gm/min
008	TIME 02:00
009	STOP
010	END

When finished entering the program, press **EXIT**, and then "**B**" for Edit again, and you will see the following screen:

000 START		009
Next	Delete	Last
A	B	C

Since the START and END statements cannot be entered manually, and can't be deleted either, they are not included in the line count shown here as 009, when one might think it should be 010 or even 011. This represents the count of the lines that you actually entered.

After setting the above parameters, it's time to prime the ChemTec. Press the **EXIT** key on the front panel until the Mode Select screen is seen. From the Mode Select screen, use "**A**" or "**B**" to go up or down to the "MANUAL" mode. The following is displayed:

Mode Selct		MANUAL
Up	Down	Select
A	B	C

Press "**C**" to select, and the screen will change to the following:

- MANUAL -	100.0%	
Sw=0000		CW
A	B	C

Press the "**RUN**" key and allow the ChemTec to run until all air is removed from the tubing between the Media Reservoir and the Bioreactor. Press the "**STOP**" key to stop the pump.

Pressing the "**EXIT**" key returns one to the Mode Select screen. Use the "**A**" and "**B**" buttons to scroll to the "MASS FLOW" mode. Press "**C**" to Select it, and "**A**" to Execute and the following screen will be displayed:

MASS FLOW	10.00gm/m
Press RUN when Ready	

When you are ready, Press the RUN key, and the following screens will be displayed:

-SCALE INITIALIZATION-
Please Wait

REMOVING TARE WEIGHT
Please Wait

00:00:00			RUN
CW	0.0gm	PR	10.00

PR= Pump Rate (grams/minute), CW= Cumulative Weight (grams), 00:00:00 = Relative (Run) Time (hrs:min:sec), RUN = Pump Status.

NOTE: The Cumulative Weight values will remain if the process is interrupted and restarted, whether it is via an alarm, or the use of the **STOP** or **EXIT** keys. Use the Clear Totals option in the Setup Menu, or when prompted after pressing "Exit" at the end of a run to clear this value.

This program demonstrates both a constant and linear feed rate. Refer to Section C of the ChemTec manual for additional examples of programs that generate exponential feeds, time delayed feeds, chromatography applications, and the use of the 6 position rotary valves.

Documentation:

The ChemTec will output data to a printer or PC at periodic user-definable intervals for archival purposes. The following is an example of that data:

09/10/09; 13:42; CHEM 0.11X; Mass Flow; Tubing=15; Units=psi; Alarms; CW=1;PR=3; EP=1; HP=1 Limits; CW= 0.0gm; HP=30.0

RT, CW, PR, VP, WP, P1, T, A1, A2, A3, ST,

00:00:00, 0.0, 10.00, 0, 0, 0.0, 24.2, 0, 0, 0, START
00:00:30, 11.1, 10.00, 0, 0, 0.0, 24.2, 0, 0, 0, RUN
00:01:00, 11.0, 10.00, 0, 0, 0.0, 24.2, 0, 0, 0, RUN
00:01:30, 17.5, 10.00, 0, 0, 0.0, 24.2, 0, 0, 0, RUN
00:02:00, 17.5, 10.00, 0, 0, 0.0, 24.2, 0, 0, 0, RUN
00:02:30, 17.5, 10.00, 0, 0, 0.0, 24.2, 0, 0, 0, RUN
00:02:37, 17.5, 10.00, 0, 0, 0.0, 24.1, 0, 0, 0, STOP AL=PR,
00:02:37, 17.5, 10.00, 0, 0, 0.0, 24.2, 0, 0, 0, EXIT AL=PR,

RT = Relative (Run) Time, hh:mm:ss. (Will be MT, Military Time if system set for "Time of Day")
CW = Cumulative Weight.
PR = Pump Rate, displays the pump rate at that moment in time.
VP= V Position, represents the position of Valve "V" (will be 0 if not in use, otherwise 1-6)
WP=W Position, represents the position of Valve "W" (will be 0 if not in use, otherwise 1-6)
ST = STATUS, Pump Status (Start, Run, Pause, Run, Exit)
AL = ALARM, Print out of Alarm condition. AL=PR represents Pump Rate Alarm, AL = CW represents Cumulative Weight Alarm, AL=EP represents End of Program Alarm.

NOTE: Three alarm levels are defined and displayed in the program header of the printout as follows: 1 = Off (Deactivated); 2 = Beep Only (Metering continues, auditory beep/5V output to remote alarm occurs); 3 = Stop pump (Stops the pump, auditory beep/5V output to remote alarm occurs). Immediate data printout occurs when RUN, STOP or EXIT keys are pressed, and when an alarm occurs. All other printouts occur at a user definable frequency in minutes : seconds (Mode: Setup, Printer, Time).

SciLog recommends a factory cleaning, testing and recalibration of the ChemTec at least once a year, to maintain the accuracy of the unit and reduce downtime. SciLog also has loaner units available to rent if you need to keep production running while SciLog is performing maintenance. Call SciLog at 800-955-1993 for an RGA and arrange for a loaner if needed.

The following chart shows tubing dimensions and the available flow rates based on tubing and motor size:

MasterFlex Tubing	13	14	16	25	17	18	15	24	35
Tubing ID*: in	0.030	0.060	0.125	0.190	0.250	0.310	0.190	0.250	0.310
Tubing OD*: in	0.157	0.189	0.251	0.314	0.376	0.439	0.376	0.439	0.500
Tubing Wall*: in	0.063	0.063	0.063	0.063	0.063	0.063	0.093	0.093	0.093
Pump Rate Range*:	ml/min	ml/min	ml/min	ml/min	ml/min	ml/min	ml/min	ml/min	ml/min
CP-8 8RPM	0.03 - 0.45	0.10 –1.63	0.43-6.38	0.9 - 12.6	1.14 -18.3	1.7 - 24.3	0.45 – 13	0.65 – 20	0.8 - 32
CP-120 160RPM	0.5 - 10	1.7 - 35.2	6.3 - 129	12.5 - 283	18.5 - 405	24.7 - 554	9 – 260	13 – 435	16 – 650
CP-200 600RPM	2 - 34	8.6- 132	29 - 533	49 -974	70 - 1048	103 - 1515	59-993	85-1348	111 - 2258
* Nominal Values									
Pump Head Model:	TANDEM 1081						TANDEM 1082		

Start-up: “Simple pH Maintenance of a “Base” reaction”

Equipment: You will need the following items to get started:

SciLog P/N	Description	Quantity
200-CHEM-1181	ChemTec, CP-120 w/ 1081 Tandem Peristaltic Head, 160rpm Motor	1 pc
080-091	pH / ChemTec Interface Cable	1 pc
400-116	Silicone Tubing, Platinum Cured, #16	25 ft (1 pkg)
080-095A	Printer Kit, includes Printer, Cable, 6 rolls Paper	1 kit
	pH Meter & Probe with 4-20ma output	1 pc
	Appropriate Acid Solution Reservoir	1 pc
	Appropriate Reaction Vessel w/ stirrer	1 pc

Hardware Setup:

1. Unpack all the components, visually identify and inspect for damage.
2. At the pH bench, place the reagent reservoir to the far left. Moving to the right on the bench, place the ChemTec, and then the Reaction Vessel and pH Meter with Probe. Leave some space between these items to allow for cables and tubing.
3. Connect the printer interface cable between the rear of the printer and the “Printer” connector on the rear of the ChemTec. This cable does not have its ends labeled, as it is the same on both ends and may be reversed. Place the printer in a convenient location.
4. Connect the pH / ChemTec interface cable to the output of the pH Meter, and the DB37 connector on the rear of the ChemTec.
5. Plug in and power-up all the equipment.
6. Cut approx. 6-8 ft. of the #16 tubing and connect it to the Reagent reservoir. Route the tubing from the reservoir to the ChemTec, open the head by rotating the lever 180 degrees counter-clockwise, and place the tubing over the upper set of rollers. Confirm that the tubing is under the centering springs and close the head by rotating the lever back to its original position. Connect the remaining end to the Reaction Vessel. This completes the hardware and tubing configuration.

Program Editing and Execution:

At this point, please consider the parameters of the titration/maintenance process and determine how close the pH Setpoint must be maintained and the max flow rate desired for reagent addition as the pH increases.

Several user-definable alarms may be utilized to monitor upper and lower pH limits, and the reagent volume. Alarms and Limits may also be set for Pressure and Temperature in the submenus for those items in Setup Mode. All the alarms may be set to “**Off**” (disabled), “**Alarm Only**” (an audible alarm), and “**Pump Stop**” (stops the pump and sounds the audible alarm).

Press the “**EXIT**” button several times to reach the top of the menu:

Mode Selct		MASS FLOW
Up	Down	Select
A	B	C

Press “**A**” to scroll up until the following appears:

Mode Selct	PH CONTRL	
Up	Down	Select
A	B	C

Press "**C**" to Select, and this screen now appears:

- PH CONTROL -		
Exec	Edit	Alarm
A	B	C

Pressing "**C**" for Alarm provides access to the following parameters:

- **REAGENT VOLUME:** Set the appropriate option for this alarm, **OFF**, **Alarm Only**, or **Pump Stop**. Use "**Pump Stop**" if this is a critical alarm. Press "**C**" to select, "**A**" and "**B**" to scroll thru the selections, and "**C**" again to select.
- **REAGENT LIMIT:** This alarm will occur when a user-definable cumulative reagent volume limit has been dispensed. Press "**C**" to Select, then use "**A**" and "**B**" to increase or decrease the amount, up to a total of 9,999 ml. (depending on the calibration curve), then press "**C**" to Select the amount. This sets the limit for the Reagent Volume Alarm above.
- **HIGH - PH:** Set the appropriate option for the Hi-pH Alarm, **OFF**, **Alarm Only**, or **Pump Stop**. Use "**Pump Stop**" if this is a critical alarm. Press "**C**" to select, "**A**" and "**B**" to scroll thru the selections, and "**C**" again to select.
- **HIGH LIMIT:** Set the Limit for the Hi-pH Alarm. The alarm will occur when the limit is exceeded. Maximum and default setting: 14.0.
- **LOW - PH:** Set the appropriate option for the Low-pH Alarm, **OFF**, **Alarm Only**, or **Pump Stop**. Use "**Pump Stop**" if this is a critical alarm. Press "**C**" to select, "**A**" and "**B**" to scroll thru the selections, and "**C**" again to select.
- **LOW LIMIT:** Set the Limit for the Low-pH Alarm. The alarm will occur when the value drops below the specified limit. Minimum and default setting: 0.0.

pH Control: Edit:

The ChemTec will automatically dispense an Acid or Base Reagent to a titration vessel as it deviates from a user-defined Setpoint based upon the settings of the following list of parameters:

- **SETPOINT:** A single pH value between 0.00 and 14.00 is entered. This is the pH that is maintained by the ChemTec. For titrations, the Setpoint is the titration endpoint, e.g. pH = 7.00 for simple acid or base neutralization. Default = 7.0
- **PUMP TUBING:** Select a pump tubing size that can accommodate the desired pump rate. Refer to the chart on the side of the ChemTec flow rate ranges with different tubing / motor sizes.
- **CLEAR TOTALS:** Use this to clear the cumulative volume values before or after a run.
- **PUMP RATE:** This is the maximum desired reagent addition rate (default = 1.0 ml/m). As a first approximation, select a pump rate that is approximately 10% of the expected titration volume. The ChemTec slows down as the Setpoint is approached, and speeds as the measurement gets further away. See: Delta.
- **ENDPOINT DELAY:** For pH maintenance, the Endpoint Delay should be set to 0 seconds. With this setting the Setpoint can be maintained indefinitely within a 0.1pH unit range, i.e. the smallest pH-BANDWIDTH.

For Endpoint titrations the Endpoint Delay should be set to something other than 0 seconds. The Endpoint Delay represents the time period in seconds during which a constant Setpoint must be maintained. If the pH has not sufficiently stabilized during the Endpoint Delay period because of incomplete mixing, the pump may turn on again and deliver additional small aliquots of reagent. The Endpoint Delay counter will be reset when the ChemTec turns on during the Endpoint Delay period. The titration has been successfully completed with the expiration of the Endpoint Delay.

- **BANDWIDTH:** The Bandwidth setting determines how far the solution pH can deviate from the SETPOINT before the ChemTec starts delivering reagent.
- **DELTA:** Represents the pH range (default: DELTA = 1.00) during which the pump speed is automatically reduced from the maximum PUMP RATE setting. The DELTA value should be increased or the pump rate should be decreased if the SETPOINT is repeatedly exceeded during titration. Example: with a Setpoint of 7.0, a Bandwidth of 0.1 and a Delta of 4.0, the system will add at the maximum Pump Rate setting at a pH of 11.0 and decrease linearly to the minimum flow rate as the Setpoint is approached. Addition will cease once pH drops below 7.1 pH.
- **REAGENT:** Either ACID or BASE must be selected. This is the reagent that the ChemTec will be pumping into the reactor.

pH Control: Execute:

Prior to executing the pH Control mode, it is necessary to set the Analog Input to match the output of the pH Meter in use.

With the cable connected between the two, and the pH Meter set at 0.0 pH, or 4mA output, enter pH Control Mode. Press Edit, scroll to “D1 Input 4 mA” and confirm that it is set to 0.0. Press Select and scroll to “D1 Input 20mA” and confirm that it is set to 14.0. (If using a tighter range meter with a 4-20 mA output, this is where the range would be changed.) With the Pump Rate set at 0.0, place the pH probe into a standard buffer, and note the reading on the pH meter and the ChemTec. It is not unusual for these readings to differ, and there is a Sensor Offset value that can be set to allow for this difference. The desired Pump Rate can now be reset, and the process is ready to start.

Pressing the “**EXIT**” on the ChemTec will return you to the Mode Select screen. Use the “**A**” and “**B**” buttons to scroll to the “PH CONTRL” mode. Press “**C**” to Select it, and “**A**” to Execute and the following screen will be displayed:

SETPOINT: 7.00 ACID
Press RUN when Ready

When you are ready, Press the RUN key, and the following screen is displayed:

00:00:00			R	0.0
PH	0.00	A	SET	7:00

Relative (Run) Time (hrs:min:sec) = **00:00:00** is displayed**; R** = Reagent Volume, calculated by the internal calibration curve; **PH**= pH units, as measured by the pH Meter, **A** = Acid, will display as B if a Base is chosen as the reagent; **SET** = pH Setpoint.

If all is working as expected for a “Acid” reaction acid is the reagent being added to bring the solution back to a neutral Setpoint of 7.0 pH, when the pH exceeds 7.10 (Bandwidth=0.1) the ChemTec will begin to slowly dispense the Acid Reagent. This speed will increase linearly to the maximum Pump Rate that was set as the Delta value is approached. It will automatically slow down as the pH returns toward 7.1 and stop when it drops below that value. With an Endpoint Delay of 0.0, this will continue for as long as desired.

If this process to occur once and stop, as in an Endpoint Titration, set the Endpoint Delay to a non-zero value in seconds. (Maximum = 180 seconds) As long as the pH stays within the bandwidth setting for the length of the Delay, the process is considered complete when the delay timer expires. If more addition occurs during this delay period, i.e. the solution, once homogenous is back outside the Bandwidth setting, the delay timer is reset.

NOTE: The Reagent Volume values will remain if the process is interrupted and restarted, whether it is via an alarm, or the use of the **STOP** or **EXIT** keys. The Clear Totals option in the Edit Menu, or when prompted after pressing "Exit" will allow you to reset these values.

Documentation:

The ChemTec will output data to a printer or a PC at periodic user-definable intervals for archival purposes. The following is an example of that data:

09/10/09; 14:52; CHEM 0.11X; Ph Control; CW; Tubing=15; Units=psi; ALARMS: RV= 3; HI=1; LO=1; P1=1; LIMITS: RV= 1.00; HI=14.00; LO= 0.00; HP=30.0; HT=35.0
RT, PH, RV, , , P1, T, , , , ST,

00:00:00, 7.00, 0.0, , , 0.0, 24.6, , , , START
00:00:30, 7.00, 0.0, , , 0.0, 24.6, , , , RUN
00:01:00, 7.00, 0.0, , , 0.0, 24.6, , , , RUN
00:01:30, 7.00, 0.0, , , 0.0, 24.5, , , , RUN

RT = Relative (Run) Time, hh:mm:ss. (Will be MT, Military Time if system set for "Time of Day")
PH = pH units as measured by the pH Meter.
RV = Reagent Volume. P1 = Pressure, psi.
T = Temperature, ºC ST = STATUS, Pump Status (Start, Run, Pause, Run, Exit)
AL = ALARM, Print out of Alarm condition.
LO = Lo pH Alarm. HI = Hi pH Alarm. CW = Clockwise motor direction.

NOTE: Three alarm levels are defined and displayed in the program header of the printout as follows: 1 = Off (Deactivated); 2 = Alarm Only (Metering continues, auditory beep/5V output to remote alarm occurs); 3 = Pump Stop (Stops the pump, auditory beep/5V output to remote alarm occurs). Immediate data printout occurs when RUN, STOP or EXIT keys are pressed, and when an alarm occurs. All other printouts occur at a user definable frequency in minutes: seconds (Mode: Setup, Printer, Time)

SciLog recommends a factory cleaning, testing and recalibration of the ChemTec at least once a year, to maintain the accuracy of the unit and reduce downtime. SciLog also has loaner units available to rent if you need to keep production running while SciLog is performing maintenance. Call SciLog at 800-955-1993 for an RGA and arrange for a loaner if needed.

The following chart shows available flow rates based on tubing and motor size:

MasterFlex Tubing	13	14	16	25	17	18	15	24	35
Tubing ID*: in	0.030	0.060	0.125	0.190	0.250	0.310	0.190	0.250	0.310
Tubing OD*: in	0.157	0.189	0.251	0.314	0.376	0.439	0.376	0.439	0.500
Tubing Wall*: in	0.063	0.063	0.063	0.063	0.063	0.063	0.093	0.093	0.093
Pump Rate Range*:	ml/min	ml/min	ml/min	ml/min	ml/min	ml/min	ml/min	ml/min	ml/min
CP-8 8RPM	0.03 - 0.45	0.10 –1.63	0.43-6.38	0.9 - 12.6	1.14 -18.3	1.7 - 24.3	0.45 – 13	0.65 – 20	0.8 - 32
CP-120 160RPM	0.5 - 10	1.7 - 35.2	6.3 - 129	12.5 - 283	18.5 - 405	24.7 - 554	9 – 260	13 – 435	16 – 650
CP-200 600RPM	2 - 34	8.6- 132	29 - 533	49 -974	70 - 1048	103 - 1515	59-993	85-1348	111 - 2258
* Nominal Values									
Pump Head Model:	TANDEM 1081						TANDEM 1082		

Part A: ChemTec Hardware

1.0 ChemTec Pump Heads: Overview

The ChemTec pumps provide high precision, high accuracy metering capability. The different ChemTec pump models utilize optically encoded, servo-controlled motors, ensuring a highly reproducible pump performance.

The ChemTec offers a range of pump head options:

- **CP models** come with the TANDEM ™ dual channel peristaltic pump head which are powered by an 8 (CP-8), 160 (CP-120) or 600 RPM (CP-200) motor. Two different TANDEM pump heads are available. Either thin-walled; TANDEM model 1081 or thick-walled pump tubing; TANDEM model 1082 may be used
- **FM models** come with a FMI rotating, reciprocating piston pump head, which are powered by a 160 (FM-120), 600 (FM-200) or 3400 RPM (FM-520) motor. Several different FMI pump heads are available covering a wide range of pump outputs.
- **MP models** come with a magnetically coupled, geared pump head (Micropump™) which are powered by a 3400 RPM (MP-320) motor. Several different Micropump pump heads are available. Consult Section 1.2 of this manual, which summarizes the pump head/motor options in greater detail.

1.1 PumpSense™: Pump Overload Protection

When the installed pump head requires excessive torque because of pump tube failure or "freezing" of the pump head, then the ChemTec control software will recognize this condition and go into a stand-by mode, the pump motor is turned off and the following message is displayed:

CHECK PUMP HEAD Press Any Key

Before continuing with the process, remove the defective pump head and either clean the pump head or replace it with a functional pump head. The PumpSense™ feature has been implemented as a failsafe device to protect your pump head and motor control circuit from permanent damage. Some examples of situations that may produce pump head failure are:

- **TANDEM™ Peristaltic Heads:** Pump tubing can become frayed when overused. When this happens, the pump tubing tends to wind itself around the pump rotor: To avoid this problem, check the pump tubing daily, move the used tube section 3-4 inches toward the pump discharge side. Use only high quality Silicone or PharMed pump tubing.
- **FMI Pump Heads:** Main cause: Freezing of the piston because of crystallization of the process fluid in the head: Disassemble and clean pump head if necessary. Flush all lines as well as pump head for at least 2-3 minutes after each use with an appropriate solvent to clean the pump head. *Store the head by installing a short piece of tubing between the pump inlet and outlet. Fill the tubing loop with distilled water or alcohol (IPA) and exercise the pump once a month.*
- **Micropump Heads:** Main cause: Misalignment of driving magnet due to excessive fluid viscosity, also freezing of spur gears because of crystallization of fluid inside the pump head: Reduce pump speed and/or pressurize fluid reservoir when dealing with viscous fluids. Disassemble and clean pump head if necessary. Flush all lines as well as pump head for at least 2-3 minutes after each use to avoid drying out of the liquid inside the pump head. Store the pump by installing a short piece of tubing between the pump inlet and outlet. Fill the tubing loop with distilled water or alcohol (IPA).

1.2 Pump Head/Motor Options: *Summary*

Peristaltic Models:

ChemTec CP-120: Comes with a 160 RPM, optically encoded, servo-controlled motor and a TANDEM™ Dual Channel Peristaltic Pump Head. Two pump head models are available, TANDEM 1081 & 1082. Materials of Construction: Stainless Steel and Noryl high impact plastic, four (4) roller design (stainless steel). Passive pump tube retention, two stainless steel forks automatically engage pump tubing when the TANDEM pump head is closed. The TANDEM Model 1082 (P/N: 080-1082) is compatible with thick-walled (0.093") Masterflex tubing sizes 15, 24 & 35. Optionally, the TANDEM Model 1081 (P/N: 080-1081) is available and is compatible with thin-walled (0.062") Masterflex® pump tube sizes 13, 14, 16, 25 & 17. #18 tubing is not recommended.

ChemTec CP-8: Comes with an 8 RPM, optically encoded, servo-controlled motor and a TANDEM™ Dual Channel Peristaltic Pump Head providing an accurate, low pump rate capability, otherwise has the same specifications and available options as the ChemTec CP-120.

ChemTec CP-200: Comes with a 600 RPM, optically encoded, servo-controlled motor and a TANDEM™ Dual Channel Peristaltic Pump Head providing an accurate, high pump rate capability, otherwise has the same specifications and available options as the ChemTec CP-120.

Additional Options: Two TANDEM pump heads can be mounted together. This piggy-back arrangement requires special mounting hardware (P/N: 500-485), to provide a four-channel pumping capability.

Refer to the following chart for flow rate guidelines with peristaltic tubing:

MasterFlex Tubing	13	14	16	25	17	18	15	24	35
Tubing ID*: in	0.030	0.060	0.125	0.190	0.250	0.310	0.190	0.250	0.310
Tubing OD*: in	0.157	0.189	0.251	0.314	0.376	0.439	0.376	0.439	0.500
Tubing Wall*: in	0.063	0.063	0.063	0.063	0.063	0.063	0.093	0.093	0.093
Pump Rate Range*:	ml/min	ml/min	ml/min	ml/min	ml/min	ml/min	ml/min	ml/min	ml/min
CP-8 8RPM	0.03 - .45	0.10 –1.63	0.43-6.38	0.9 - 12.6	1.14 -18.3	1.7 - 24.3	0.45 – 13	0.65 – 20	0.8 - 32
CP-120 160RPM	0.5 - 10	1.7 - 35.2	6.3 - 129	12.5 - 283	18.5 - 405	24.7 - 554	9 – 260	13 – 435	16 – 650
CP-200 600RPM	2 - 34	8.6- 132	29 - 533	49 -974	70 - 1048	103 - 1515	59 - 993	85 - 1348	111 - 2258
* Nominal Values									
Pump Head Model:	TANDEM 1081						TANDEM 1082		

Piston Head Models:

ChemTec FM-120: Uses a 160 RPM optically encoded, servo-controlled motor. The ChemTec FM-120 has a FMI rotating, reciprocating piston pump head. Wetted parts: Ceramic piston and cylinder with pump head body either made out of Kynar or Tefzel. Exception: RHOO pump head model has stainless steel (1/8"ID) piston. "LF" designation refers to a "Low Flow/Low Dead Volume" pump connection, utilizing ¼ - 28 HPLC fittings. All piston pump heads have a maximum pressure rating of 100psi.

Pump Head Model:	Max. RPM:	Pumping Range:
RHOO, 0 – 0.025 ml/stroke	160 RPM	0.022 – 4.0 ml/min.
RHO, 0 – 0.050 ml/stroke	160 RPM	0.044 – 8.0ml/min.
RH1, 0 – 0.10 ml/stroke	160 RPM	0.088 – 16.0 ml/min.

The cited pumping ranges are based on the following assumptions: Maximum pump rate = (Max. Stroke Volume) x (Max RPM); with the stroke vernier setting at 450. Minimum pump rate = (Minimum Stroke Volume) x (Min RPM); stroke vernier setting at 50.

ChemTec FM-200: Uses a 600 RPM optically encoded, servo-controlled motor. The pump head has the same features as the FM-120 above.

Pump Head Model:	Max. RPM:	Pumping Range:
RHOO, 0 – 0.025 ml/stroke	600 RPM	0.08 – 15.0 ml/min.
RHO, 0 – 0.050 ml/stroke	600 RPM	0.17 – 30.0 ml/min.
RH1, 0 – 0.10 ml/stroke	600 RPM	0.33 – 60.0 ml/min.

ChemTec FM-520: Comes with a 3400 RPM, optically encoded, servo-controlled motor. The pump head has the same features as the FM-120 above.

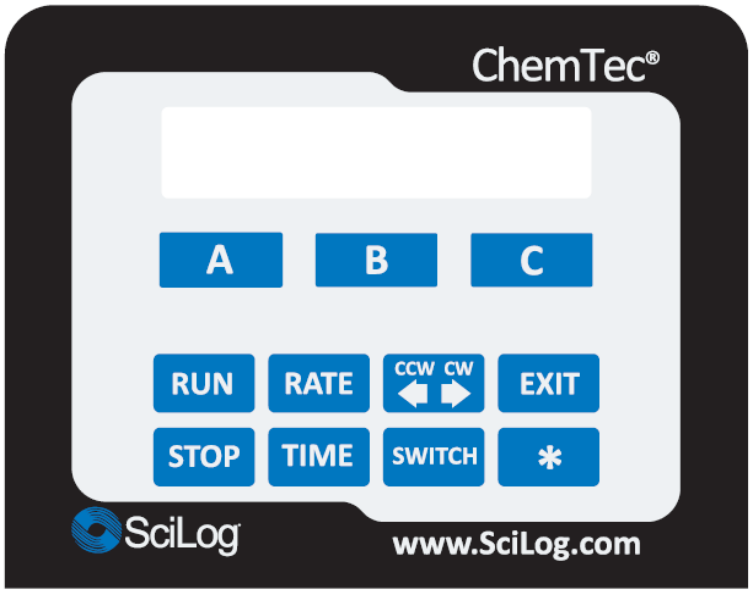
Pump Head Model:	Max. RPM:	Pumping Range:
RHOO, 0 – 0.025 ml/stroke	3400 RPM	0.50 – 85.0 ml/min.
RHO, 0 – 0.050 ml/stroke	3400 RPM	1.00 – 170 ml/min.
RH1, 0 – 0.10 ml/stroke	3400 RPM	2.00 – 340 ml/min.

Magnetic Gear Models

ChemTec MP-320 Models: Uses a 3400 RPM, optically encoded, servo-controlled motor and a magnetic gear pump head. Materials of construction: stainless steel body, gears are made from Teflon, Graphite or Ryton, depending upon model. Pressure rating: 40 – 50 psi.

Pump Head Model:	Max. RPM:	Pumping Range:
Mag. 187, Graphite gears, 40psi,	3400 RPM	5 – 60 ml/min
Mag. 184, Graphite gears, 40psi,	3400 RPM	10 – 140 ml/min.
Mag. 1840, Ryton gears, 40 psi,	3400 RPM	30 – 312 ml/min.
Mag. 040, Teflon gears, 40 psi,	3400 RPM	85 – 1075 ml/min.
Mag. 120, Teflon gears, 50 psi,	3400 RPM	174 – 2170 ml/min.
Mag. 122, Teflon gears, 50 psi,	3400 RPM	309 – 3100 ml/min.
Mag. 200, Ryton gears, 50psi,	3400 RPM	150 – 1910 ml/min
Mag. 201, Ryton gears, 50 psi,	3400 RPM	290 - 3700 ml/min.

2.0 Front Panel: Data Entry & Display



The front panel consists of a user interface, which includes an alphanumeric display and a membrane keypad to select operational modes and alarm settings. The display is a two line, 20 characters each, liquid crystal display (LCD). The display is backlit to allow easy viewing over a wide range of lighting conditions.

The lower line on the LCD is used to signify the function of the “soft keys” marked “A”, “B” and “C”. The “soft key” current labels are displayed in the lower line of the LCD. If you press these keys, then the function displayed above it is performed.

The main keypad consists of eight “hard” keys whose function does not change. These keys are used for basic control and programming of the ChemTec. The basic key definitions are:

- RUN — Executes the selected operational mode and starts pump. (Run Command)
- STOP — Interrupts current operational mode and stops pump. (Stop Command)
- RATE — Sets pump Rate in ml/min, or gm/min, depending on Mode being implemented. (Rate Command)
- TIME — Used for Time Command.
- CCW CW — Pump direction, counter-clockwise or clockwise. (CW or CCW Command)
- SWITCH — Used to change between alternate displays in all modes. (Access to TTL 1-4 commands in Mass and Volume Flow Modes)
- EXIT — Used to Exit current operational mode or menu level, stops pump.
- * — Used for pump rate recalibration and keypad lock in Mass and Volume Flow Modes.. (Interpolate Rate, Rotary Valve, and Sample Count Commands in programmable Modes.)

Two LED’s are also on the front panel, just to the left of the main keypad. These indicate the current pump status. A green light indicates the pump is in motion; the red light indicates that the pump has stopped.

3.0 Back Panel: Interface Options

The ChemTec back panel provides interfacing ports for:

- **Printer Port:** The ChemTec can be connected to a PC for data collection or to a SciLog Printer via the female DB9 RS-232 port labeled “Printer”**.** You need a SciLog RS-232 cable (P/N 080-073) to connect to a PC for data archival, or a printer cable (080-096) to make the connection between the printer and the ChemTec.

- **Electronic Balance:** Male DB9, labeled “S1”. (S2 and S3 are not utilized in the ChemTec.)

- **Foot Switch (P/N: 080-059):** Male DB37, Labeled “External I/O”.

- **SciPres Disposable Pressure Sensors:** Three RJ11 telephone jacks, one for each pressure sensor. Labeled “P1, P2, P3”. ChemTec uses only one sensor.

- **SciTemp Disposable Temperature Sensor:** Conxall 2 pin connector. Labeled "Temperature".

- **Scale Ports:** The male DB9 ports labeled "S1", "S2" and "S3" are RS-232 ports for electronic scales. For the ChemTec, only S1 is used. This port allows the user to interface with a number of different electronic scales: i.e. Mettler, Ohaus, and Sartorius top-loading scales. The following scale cables are required:

    - Mettler: PGS, PM, Viper Models — P/N: 080-067PGS
    - Ohaus: GT, "Precision Advanced" & "Explorer" & "Voyager" Models — P/N: 080-066
    - Ohaus: IP Series High Capacity — P/N: 080-067
    - Ohaus: Adventurer Pro Series — P/N: 080-067PGS
    - Sartorius: Most Series Balances — P/N: 080-068

- **In ChemTec Setup: Scale**, select the scale manufacturer; the ChemTec will automatically implement the correct communications parameters. **Check that the proper communications parameters are also implemented in the scale being used.**

- **Pressure Sensor Ports:** RJ11 Telephone jacks for the SciPres Disposable Pressure Sensors, labeled "P1", "P2", and "P3". The SciPres disposable pressure sensors plug into these jacks using the included cable. The ChemTec uses only one sensor, any of the three may be chosen as the source location.

- **Temperature Probe Port:** The SciTemp Disposable Temperature Senor connects to this port with a twist-lock connector cable. Temperature is measured in degrees Celsius.

- **Valve V Port:** Used in conjunction a 6-way Selector Valve (P/N: 080-510) in either Mass Flow or Volume Flow Modes. Most often used for Preparative Chromatography.

- **USB Port:** Used for connection to a PC, providing a Com Port. Can be used for data collection as an alternative to the Printer port. The driver is included on the CD that contains this manual.

- **Ethernet Port:** Used for connection to the ChemTec via a LAN. IP Address, Subnet Mask, and Gateway are configured in the Setup menu. The communication protocol is Modbus TCP/IP, and a list of registers is in the appendix of this manual. (When available.)

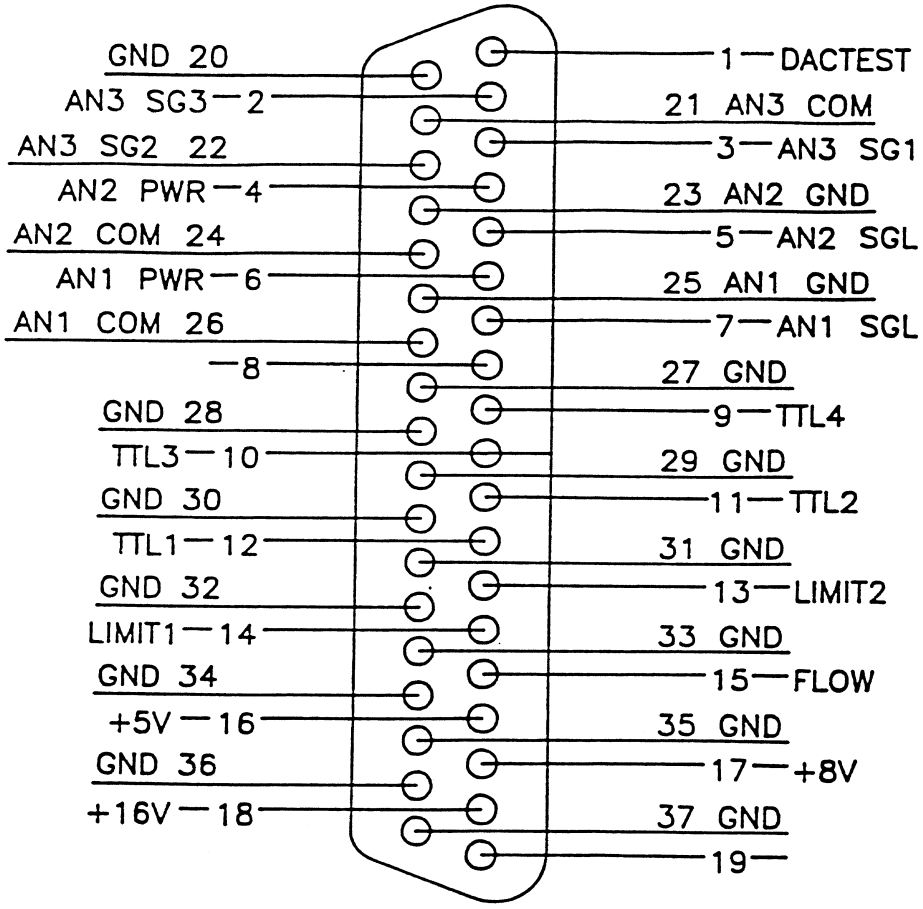
- **External I/O Connector:** DB37 connector used to interface with various devices, allowing up to three 4-20 ma Analog inputs (A1, A2 & A3) for recording data or alarming based upon that data. It also allows an interface with SciLog foot switch (P/N: 080-059) and allows remote Start / Stop control of the ChemTec**.** It is also the connection point for Valve W if in use.

  For pin configuration, consult the drawing on this page. The DB37 port at the back panel provides three analog input channels for devices providing loop power:

  - **Analog channel 1** (pin 7 signal, pin 25 ground**)**
  - **Analog channel 2** (pin 5 signal, pin 23 ground)
  - **Analog channel 3** (pin 2 signal SG3, pin 21 common)

  - When a Footswitch or External Run / Stop Cable is desired, Pins 19 and 37 are used.

Pin out of DB37 External I/O Connector on Rear Panel:



4.0 SciLog I/O Adapter Module (Optional Accessory)

The SciLog I/O Adapter Module (P/N: 080-100) is an optional accessory that greatly simplifies interfacing with external devices. The I/O Adapter Module can be directly connected to the External I/O Port (DB37 female connector) which is located on the back panel of the ChemTec.

On the SciLog I/O adapter Module are three rows of I/O ports available for interfacing with a variety of different external devices, and only the top and bottom rows are active. The center row is obsolete and no longer used. Note: Using the adapter precludes the use of Valve W for Volume or Mass Flow control.

4.1 Analog Input Signals:

The upper row of ports is designated as Analog Channels. There are three Analog Channels labeled as: CHNL 1, CHNL 2 and CHNL 3.

These three analog input channels can accommodate 4-20 mA inputs from chemical sensors, detectors, analyzers or controllers. In Analog Mode, the output of these devices can be used to proportionally control the ChemTec pump. In other modes, these signals can be monitored and alarmed. The pin-out configuration is given below:

	Channel 1	**Channel 2**	**Channel 3**
4-20 mA, current	"+" to SGNL " - " to GND	"+"to SGNL " - " to GND	"+" to SGL3 " - " to COM

NOTE: The above pin-out information assumes that loop power is supplied by the measuring device. All pin-outs refer to the configuration of the SciLog I/O Adapter Module only!
All analog inputs must be checked for the correct polarity. Change polarity of analog input leads if the pump does not respond to the analog signal.

4.2 Contact Closures (max. 2 Amperes):

The SciLog I/O Adapter Module also provides four contact closures relays on the bottom row that can be used to control external devices. The four relays are turned on or off by the four TTL switches available at the "External I/O" in the back of the ChemTec. By connecting the SciLog I/O Adapter Module to ChemTec, any of the four contact closures can be individually controlled in either Manual Mode or Mass and Volume Flow Modes.

Each of the four contact closures has three connections, Normally Open = NO, Common and Normally Closed = NC.

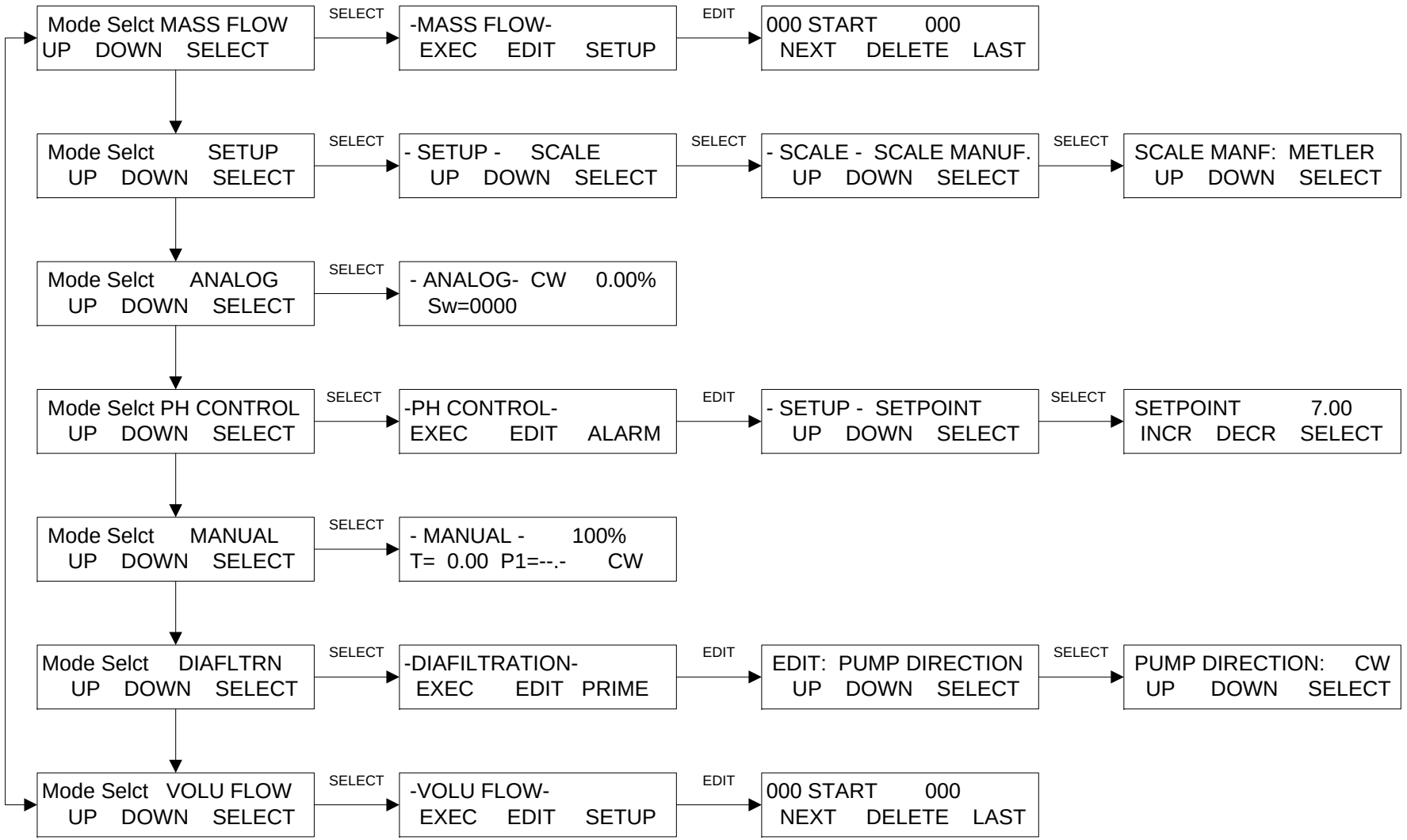
Any of the contact closures can be manually controlled in the **Manual Mode** using the **"Switch"** key. Alternatively, **"SWBit"** commands can be imbedded in the Mass Flow or Volu Flow programs to automatically control external devices. ***NOTE****: When using the Adapter Module, only one rotary valve is accessible via the "Valve V" port.*

Two types of relay controls are available:

A *momentary* (300msec pulse) contact closure can be implemented by selecting **"Pulse"** in **Setup: Switch Config.** (In **Setup: Pump** menu, select **Setup: Switch Config.**, then select **"Pulse"**.) For example, the switch command "Sw = 0200" will momentarily close Relay #2 thereby generating a pulse.

A *continuous* contact closure can be implemented by selecting **"Level"** in **Setup: Switch Config.** (In **Setup: Pump** menu, select **Setup: Switch Config.**, then select **"Level"**.) In the Level mode, the relay will remain open or closed until another "Switch" command changes the status/state of the relay. For example, the switch command "Sw = 0200" will close Relay #2 which will remain closed until the switch command "Sw = 0000" is executed thereby opening Relay #2.

1.0 MAIN MENU


Mode Selct MASS FLOW
UP DOWN SELECT
SELECT
-MASS FLOW-
EXEC EDIT SETUP
EDIT
000 START 000
NEXT DELETE LAST
Mode Selct SETUP
UP DOWN SELECT
SELECT
- SETUP - SCALE
UP DOWN SELECT
SELECT
- SCALE - SCALE MANUF.
UP DOWN SELECT
SELECT
SCALE MANF: METLER
UP DOWN SELECT
Mode Selct ANALOG
UP DOWN SELECT
SELECT
- ANALOG- CW 0.00%
Sw=0000
Mode Selct PH CONTROL
UP DOWN SELECT
SELECT
-PH CONTROL-
EXEC EDIT ALARM
EDIT
- SETUP - SETPOINT
UP DOWN SELECT
SELECT
SETPOINT 7.00
INCR DECR SELECT
Mode Selct MANUAL
UP DOWN SELECT
SELECT
- MANUAL - 100%
T= 0.00 P1=--.- CW
Mode Selct DIAFLTRN
UP DOWN SELECT
SELECT
-DIAFILTRATION-
EXEC EDIT PRIME
EDIT
EDIT: PUMP DIRECTION
UP DOWN SELECT
SELECT
PUMP DIRECTION: CW
UP DOWN SELECT
Mode Selct VOLU FLOW
UP DOWN SELECT
SELECT
-VOLU FLOW-
EXEC EDIT SETUP
EDIT
000 START 000
NEXT DELETE LAST

Part B: ChemTec Software

1.0 Overview: Main Menu

The ChemTec main menu consists of seven (7) operational modes as shown in on the previous page. Use the **"Up"** and **"Down"** keys to scroll through the main menu. Press the **"Select"** key to enter a chosen operational mode, i.e. **VOLU FLOW**. By pressing the **"Select"** key the 1st submenu level appears, providing access to **"Exec"** and **"Edit".** In the **Edit** sub-mode, the pump parameters are selected for the metering application.

MASS FLOW: In this programmable operational mode, the ChemTec meters solutions by weight with high levels accuracy and precision. No pump calibration is required; the selected mass flow rate is independent of environmental factors. The solution reservoir or the chemical reactor is positioned on an electronic balance. By continually monitoring the balance output, the ChemTec adjusts the pump speed to maintain a selected mass flow rate. The flows can be constant, and can change in a stepped or interpolated manner. The ChemTec can be interfaced with balances and scales from several manufactures: Mettler, Ohaus, and Sartorius. It is preferable that this be purchased from SciLog so it may be properly configured and tested as a system.

VOLU FLOW: The Volume Flow Mode programmable in the same manner as Mass Flow Mode. The ChemTec output in this mode is based upon internal calibration curves that may be re-calibrated for a particular pump head and/or pump tube combination. Once calibrated, the ChemTec meters solution volumetrically at user-definable rates with excellent precision and accuracy.

PERFUSION: (also referred to as Diafiltration) In this mode the ChemTec automatically meters fresh media into a bioreactor in response to the continuous removal of cell-free permeate containing the expressed protein. Interface with a balance placed under the bioreactor is required. A Perfusion system usually also incorporates a PureTec and an ACCU, or additional ChemTec. This mode may also be used in a subtractive manner to remove solution from a vessel to maintain its weight.

pH: The ChemTec automates pH maintenance as well as end point titration in small to medium volume reactor applications. The ChemTec is connected to a Process pH Transmitter (with 4-20 mA output). The ChemTec provides a user-definable pH-Setpoint and pH-Bandwidth, which the ChemTec maintains by adding small increments of reagent, i.e. acid or base. The reagent addition rate is automatically reduced as the pH-Setpoint is approached. The pH-Setpoint can be maintained indefinitely within a 0.10 pH unit range, i.e. smallest selectable pH-Bandwidth.

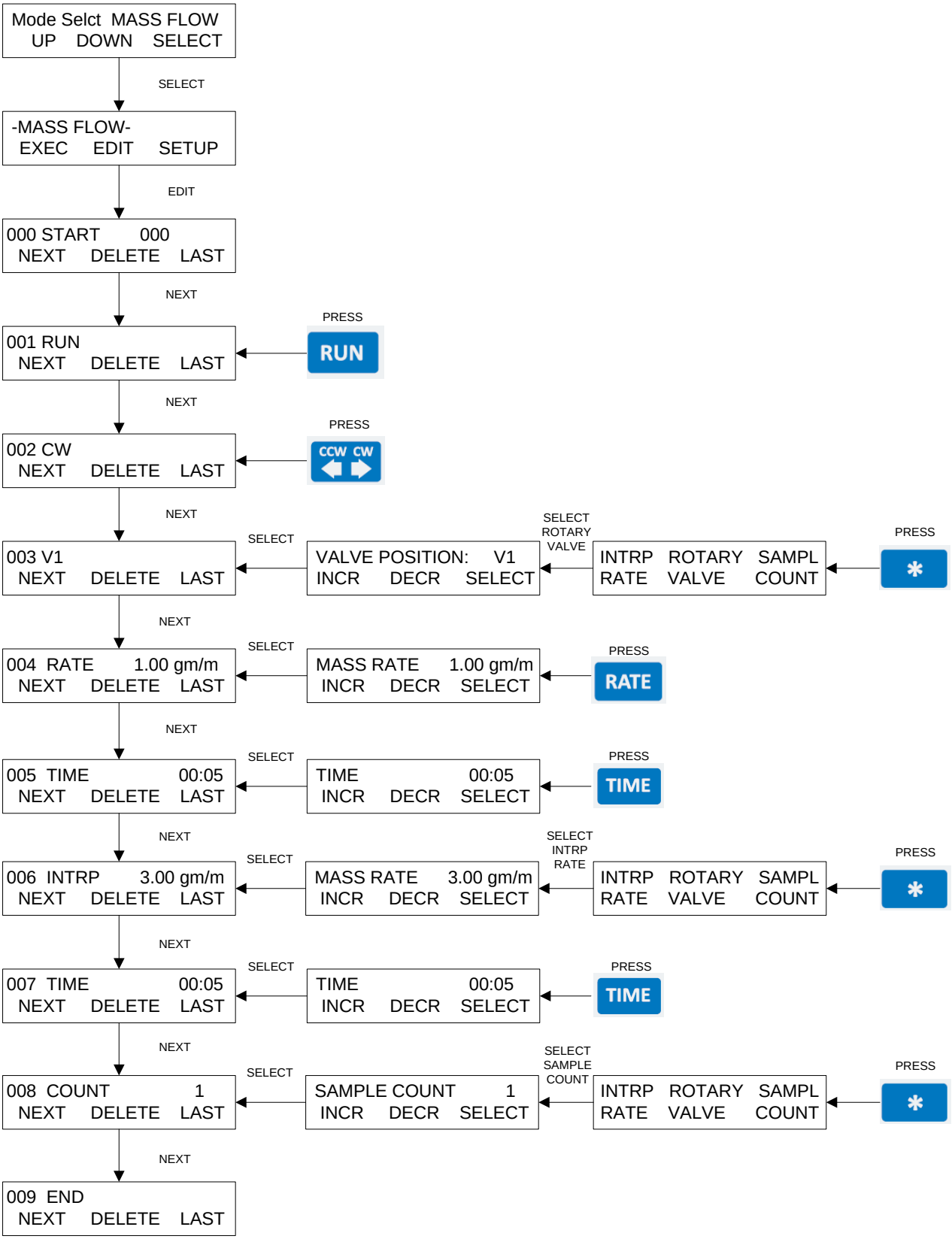
ANALOG: This mode allows direct proportional control of the ChemTec motor speed from a 4-20 mA input signal. The direction and run/stop are available via the keypad, and this mode has no data output.

MANUAL: Allows manual operation of the ChemTec, The following front panel keys are active in MANUAL: RATE, TIME, CW/CCW (double arrow key) and the SWITCH keys. The RATE key allows you change the pump speed, while the SWITCH key provides access to the four programmable TTL switches, which can be used to control external devices, i.e. valves. This mode also offers no data output.

SETUP: This operational mode allows selection of various user preferences and interface options.

- **Setup: Scale** submenu provides electronic balance options. Balances that can interface with the ChemTec must have bi-directional serial communication, and NOT have internal calibration or be “delta-range” models. Many Mettler, Ohaus, and Sartorius balances can be used.
- **Setup: Clock** submenu allows the user to set the time and date used in the display.
- **Setup: System Test** submenu allows checkout of ChemTec outputs and requires purchase of a special set of connectors to perform the test.
- **Setup: Test Mode** provides an additional mode to test the I/O’s independently.
- **Setup: Ethernet** is used to set the IP Address, Subnet Mask, and Gateway for Modbus TCP/IP communications.
- **Setup: Printer** is used for setting up the printer/PC communications parameters as well as print time interval and the print delay.
- **Setup: Analog** defines the ranges, alarms and limits for the three analog channels available for data acquisition and reporting of 4-20 ma signals from detectors equipped with analog outputs.
- **Setup: Temperature** submenu provides for Temperature Alarm and Limit as well as the input of an offset value if needed.
- **Setup: Press. Sensor** is used to zero the pressure sensors, set the units (psi, bar, kpa), and choose the source for the pressure control and alarm as well as enable the alarm and set its limit.
- **Setup: Pump** allows you to set various pump user preferences, most importantly the Motor RPM.
- **Setup: Scale2** and **Scale3** are not utilized in the ChemTec, and hence should not be modified from “None”.

2.0 MASS FLOW: Edit



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2.0 MASS FLOW: How to generate a MASS FLOW program.

SUMMARY: In the Mass Flow Mode, the ChemTec meters solutions gravimetrically, i.e. by weight. Either the solution reservoir or the chemical reactor is positioned on an electronic scale. By continually monitoring the scale output, the ChemTec adjusts the pump speed to maintain a desired mass flow rate. The selected mass flow rate is maintained by the ChemTec during each 60 second interval. If the selected mass flow rate cannot be maintained during a 60 second interval, e.g. the reservoir has run empty, the ChemTec will alert the user with an auditory signal and stop the pump, provided such an alarm option was selected.

The ChemTec also has provisions for printing / documenting the metering data & alarms. The printer (P/N: 080-095) can be connected to the ChemTec via the Port labeled “Printer”. The Printer and/or USB ports may also be used to send data to a PC, using either the SciDoc data collection software discussed later in the manual or HyperTerminal. Use **Setup: Printer** for setting up the printer communications parameters and print time interval.

When executing the Mass Flow Mode, the ChemTec will display **“SCALE INITIALIZATION // Please Wait”.** If balance communication fails, the ChemTec will display **“SCALE ERROR // Hit any key”.** Check the cable connection as well as the communications parameters in the scale. Also make sure the correct manufacturer in the **Setup: Scale** submenu has been selected.

When generating or editing a Mass Flow program, all program statements that are to be implemented during a specific timing block or interval **must precede the TIME statement for that program block.** For example, on the opposite page, the program statement: 001 RUN, 002 CW, 003 V1, and 004 RATE are all implemented at the beginning of the first timing block defined by program statement 005 TIME: 00:05 (five minutes).

CW, Pump Direction: This program statement is implemented by pressing the key with the double arrows. This key functions like a toggle switch and selects either CW (clockwise) or CCW (counter-clockwise) pump direction.

RUN: This statement is implemented by pressing the key labeled “RUN”, it instructs the ChemTec to turn on the pump motor.

V1, Valve Position: This program statement is implemented by pressing the star (*) key followed by selecting “Rotary Valve”. Six rotary valve positions for valve “V”, namely, V1 through V6, as well as, six rotary positions for a second valve “W”, W1 through W6, can be selected.

RATE, Pump Rate: Press RATE key then select the desired mass flow rate, make sure that the selected mass flow rate does not exceed the capacity of the installed pump head /motor combination.

TIME, Timing Interval: Press TIME key, then select the desired timing interval in Hours: Minutes. All preceding program statements are implemented at the beginning of this TIME statement. Max Time is 59 hours: 59 minutes.

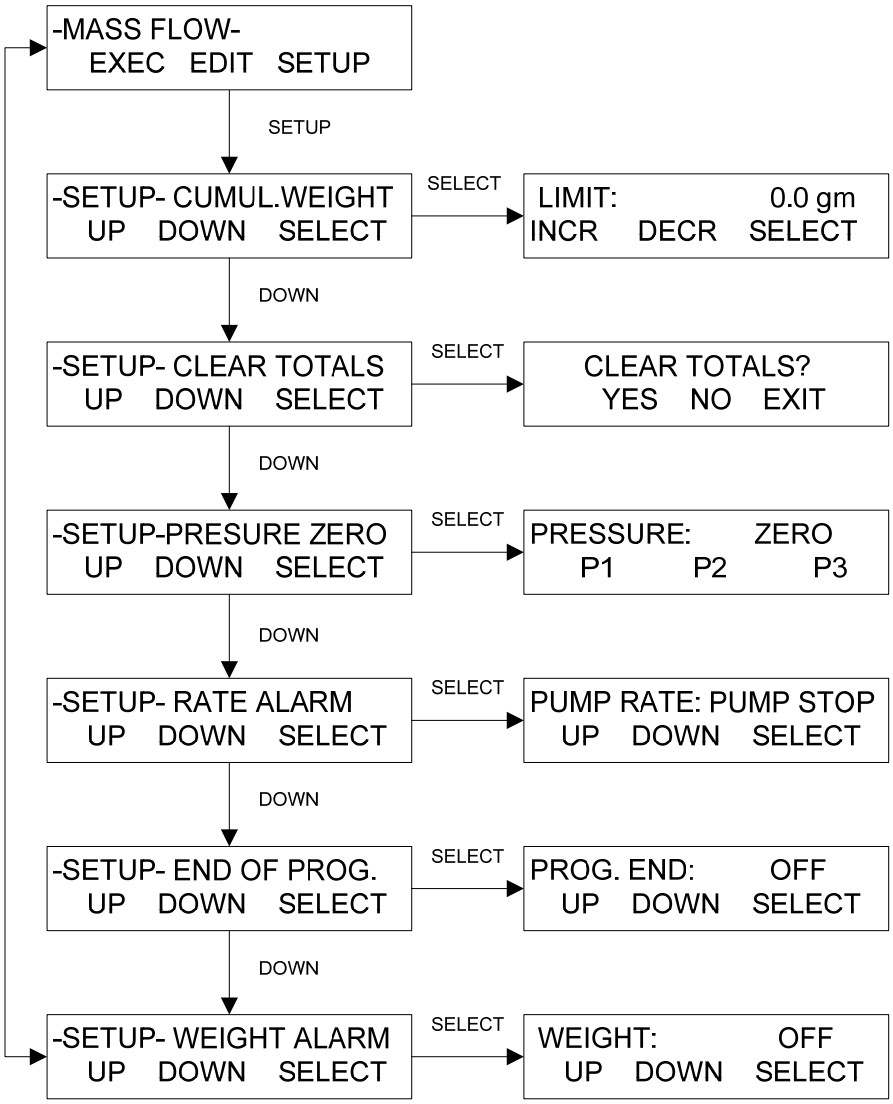
INTRP, Interpolation, Pump Ramp: Press the star (*) key, then select “INTRP RATE”, this program statement allows definition a linear pump ramp. The highest rate of the pumping ramp is given by the “INTRP RATE”, the lowest rate of the pumping ramp is defined by the preceding RATE statement. The length of the ramp is defined by a subsequent TIME statement.

COUNT: Press star (*) key, then select “SAMPL COUNT”, then select a value larger than 1 if the program is to repeat, up to 999. This command may only be used at the end of the program. Nested Count commands are not allowed.

SWBits: The TTL outputs may be controlled as part of the program. Press the “SWITCH” key and use the Left and 1/0 keys to set the state of these switches. 1234 is all high, 0000 is all low. (This is not shown in the sample program, and is rarely used.)

2.1 MASS FLOW MODE

Setup / Alarm Limits Menu



2.1 MASS FLOW Mode: Setup / Alarms / Program Editing

SUMMARY: The ChemTec allows you to define several alarm conditions, three of which are set in this submenu.

The **Cumulative Weight Alarm** defines the maximum amount (in grams) of solution to be metered by the ChemTec. For example, if the Cumulative Weight Alarm is set at 200 gm., then the ChemTec will sound an alarm and stop the pump when 200gm. of solution have been dispensed. The **Pump Rate Alarm** can be selected to either sound an alarm or stop the pump action, when the user-defined pump rate cannot be maintained. This alarm condition can occur when the solution reservoir has run dry or a leak has developed in the pump line.
The **End of Program Alarm** provides an auditory signal and stops the pump action, when the user-defined program has ended.

Three options are available for each of the alarms. The alarm can be either Off, Alarm Only (auditory signal only), or Stop Pump (auditory signal and pump stops).

The remaining alarms / limits, Hi Pressure, Hi Temperature, and Hi/Lo Analog are found in their respective submenus as part of the Main Setup Mode menu.

Setup / Alarm Settings:

- **Cumulative Weight Limit:** Select the total weight of solution to be metered. Default = 0.0
- **Clear Totals:** Use to clear the cumulative values. This will be prompted for upon pressing Exit at the end of a run.
- **Pressure Zero:** Use this interface to zero the pressure sensor if using one. Be sure there is no pressure in the system when this is done.
- **Rate Alarm:** In the metering application circumstances may arise in which the selected pump rate cannot be maintained. The Rate Alarm will alert when the selected pump rate cannot be maintained over any given 60-second interval. This alarm will also be triggered when the selected pump rate is beyond the pumping capacity of the system. In either case, the ChemTec will ramp up to 100% of motor speed before triggering the Rate Alarm. Default = Pump Stop.
- **End of Program Alarm:** Select the appropriate alarm option to be alerted when the mass flow program has come to an end.
- **Weight Alarm:** Select the appropriate alarm option for the Cumulative Weight Limit. Select one of three alarm options: Off, Alarm Only, or Pump Stop. If the Cumulative Weight Alarm is of critical importance in the application, implement the “Stop Pump” alarm option.

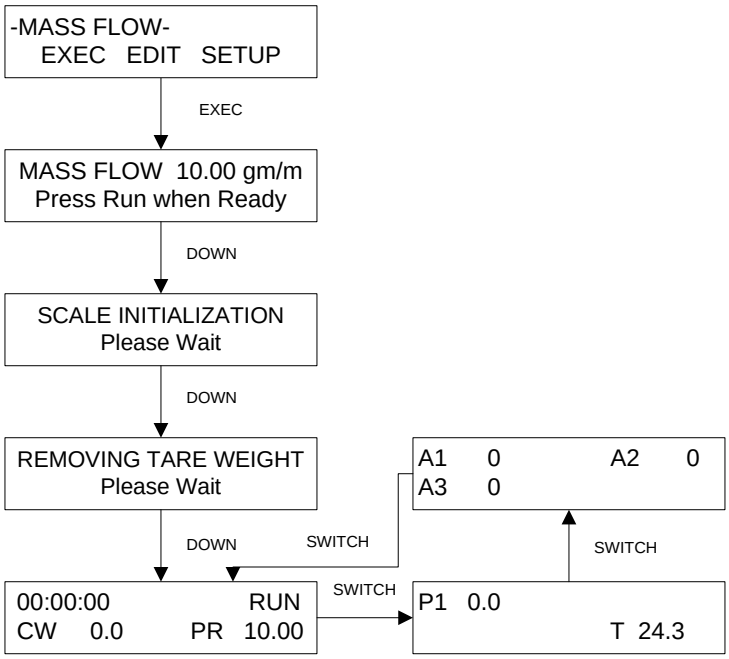
Program Editing:

Insertion of Program Statements: A program statement can be inserted at any point in the mass flow program by simply pressing a key or by selecting a pump function from the display. The program statement associated with a particular key will be inserted ahead of the previously displayed program statement.

Deletion of Program Statements: Except for the “START” and “END”, any displayed program statement can be deleted by pressing the “Delete” key (“B”). By pressing this key, the displayed statement is removed from your program. If you wish to insert a new statement in place of the deleted statement, press “Last” (“C”) then insert the new statement by pressing the appropriate keys.

2.2 MASS FLOW Mode

Execute Display



2.2 Mass Flow Mode: Execute Display

Upon pressing EXEC the ChemTec will initialize the scale, and remove the tare weight. The process begins at time 00:00:00 and the main display shows this Relative or Run Time, the Status of the ChemTec, the Cumulative Weight and the Pump Rate. By pressing the "Switch" SWITCH button on the keypad, two alternate data screens are available. The first displays the Pressure measured at by the SciPres Sensor (psi.) and the Temperature measured by the SciTemp Sensor (ºC). The second screen displays the measured value of the three available 4-20 mA analog inputs based upon their settings in Setup: Analog.

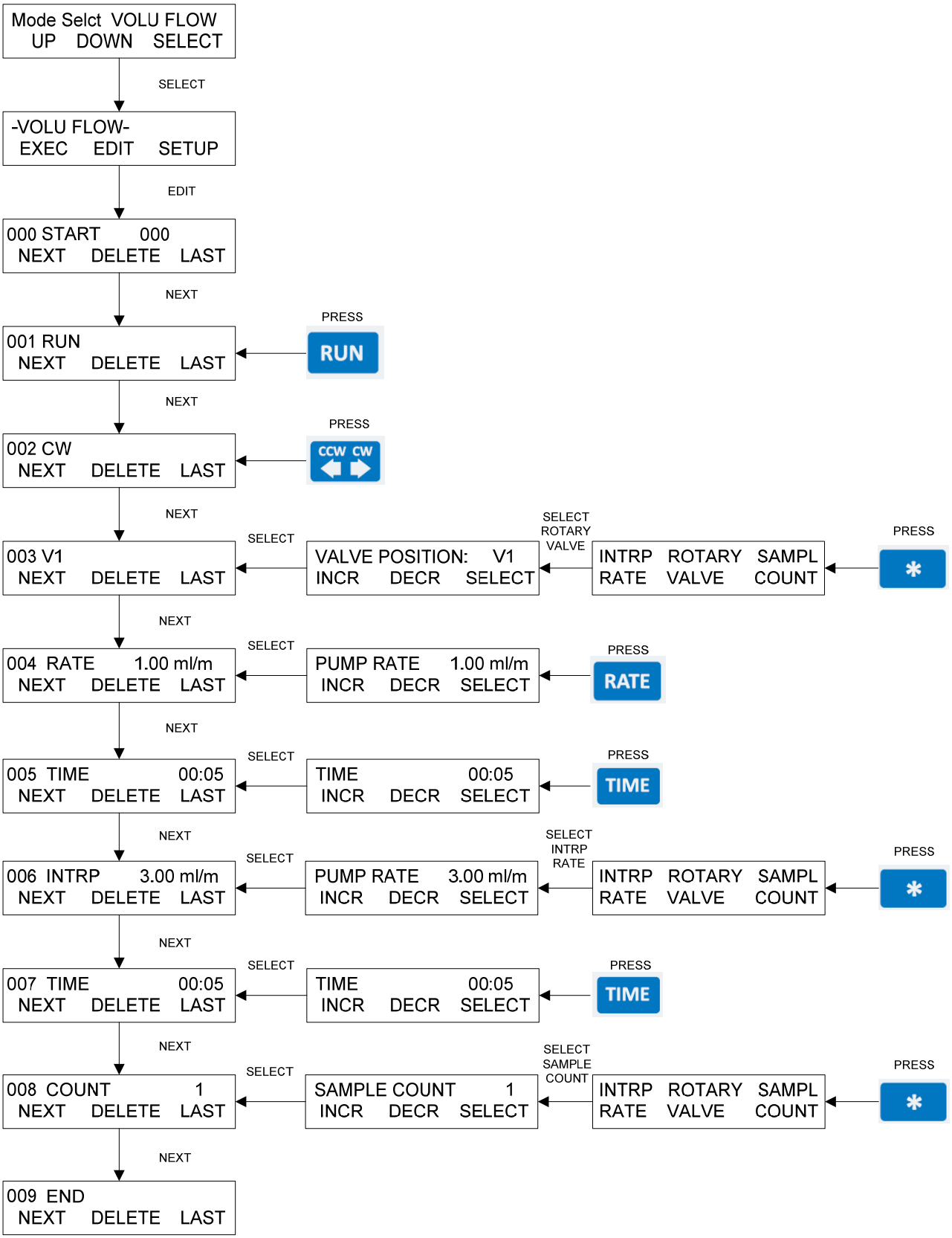
2.3 Front Panel: *Lock-out:*

When executing a ChemTec MASS-FLOW, or VOLU-FLOW, program, a limited keyboard lock-out feature is available to prevent accidental or unauthorized changes in pump status or program.

Please note, this feature is accessible to you only after you have initiated your selected mode or program, i.e. you have pressed the EXEC and RUN keys.

While the selected program or mode is being executed, press the star * button, the display will show "PUMP UNLOCKED", press key "A" labeled "LOCK" to lock the keypad. The display will revert back to operational display and the keyboard will be locked out with the exception of the star (*) key. Unlock the keyboard by pressing the star (*) key again then selecting "B" labeled "UNLOCK". The keyboard is again fully functional.

3.0 VOLU FLOW: Edit



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3.0 VOLU FLOW: How to generate a VOLUME FLOW program.

SUMMARY: In the Volume Flow Mode, the ChemTec accesses a set of built-in calibration curves for a particular pump head and/or pump tube combination for a specific motor size. Once the proper motor rpm and pump head and tubing have been chosen, the ChemTec pumps solutions volumetrically at user-definable rates with dependable precision and accuracy. This may also be re-calibrated using a simple process described later to increase the built-in precision.

When generating or editing a Volume Flow program, like the Mass Flow program, all program statements that are to be implemented during a specific timing block or interval **must precede the TIME statement for that timing block.** For example, on the opposite page, the program statement: 001 RUN, 002 CW, 003 V1, and 004 RATE are all implemented at the beginning of the first timing block defined by program statement 005 TIME: 00:05 (five minutes).

CW, Pump Direction: This program statement is implemented by pressing the key with the double arrows. This key functions like a toggle switch and selects either CW (clockwise) or CCW (counter-clockwise) pump direction.

RUN: This statement is implemented by pressing the key labeled “RUN”, it instructs the ChemTec to turn on the pump motor.

V1, Valve Position: This program statement is implemented by pressing the star (*) key followed by selecting “Rotary Valve”. Six rotary valve positions for valve “V”, namely, V1 through V6, as well as, six rotary positions for a second valve “W”, W1 through W6, can be selected.

RATE, Pump Rate: Press RATE key then select the desired volume flow rate, make sure that the selected flow rate does not exceed the capacity of the installed pump head /motor combination.

TIME, Timing Interval: Press TIME key, then select the desired timing interval in Hours: Minutes. All preceding program statements are implemented at the beginning of this TIME statement. Max Time is 59 hours: 59 minutes.

INTRP, Interpolation, Pump Ramp: Press the star (*) key, then select “INTRP RATE”, this program statement allows definition a linear pump ramp. The highest rate of the pumping ramp is given by the “INTRP RATE”, the lowest rate of the pumping ramp is defined by the preceding RATE statement. The length of the ramp is defined by a subsequent TIME statement.

COUNT: Press star (*) key, then select “SAMPL COUNT”, then select a value larger than 1 if the program is to repeat, up to 999. This command may only be used at the end of the program. Nested Count comands are not allowed.

SWBits: The TTL outputs may be controlled as part of the program. Press the “SWITCH” key and use the Left and 1/0 keys to set the state of these switches. 1234 is all high, 0000 is all low. (This is not shown in the sample program, and is rarely used.)

3.1 VOLU FLOW: How to Re-Calibrate the flow rate curves.

SUMMARY: In Volume Flow Mode, the ChemTec accesses a set of built-in calibration curves for a particular pump head and/or pump tube combination for a specific motor size. This may also be re-calibrated using a simple process. This process is necessary for all modes except Mass Flow if increased accuracy of metered volume is desired.

1. Confirm that the proper motor rpm and pump head and tubing have been chosen, this assures that the correct flow rate curve is being used.

2. Enter a simple Volume Flow program, consisting of:

   Start
   Run
   CW
   Rate XX.X ml/min (This should be the desired metering rate, or the midpoint of the rates planned on being implemented.)
   Time 00:15
   Stop

3. With nothing to impede the flow, Press Exec and Run to start the program while collecting the metered fluid in a calibrated vessel, or a vessel on a balance. Allow the program to run for 10 minutes if that's practical, and then press "Stop", followed by pressing the (*) "Star" key.

4. A screen similar to this is displayed:

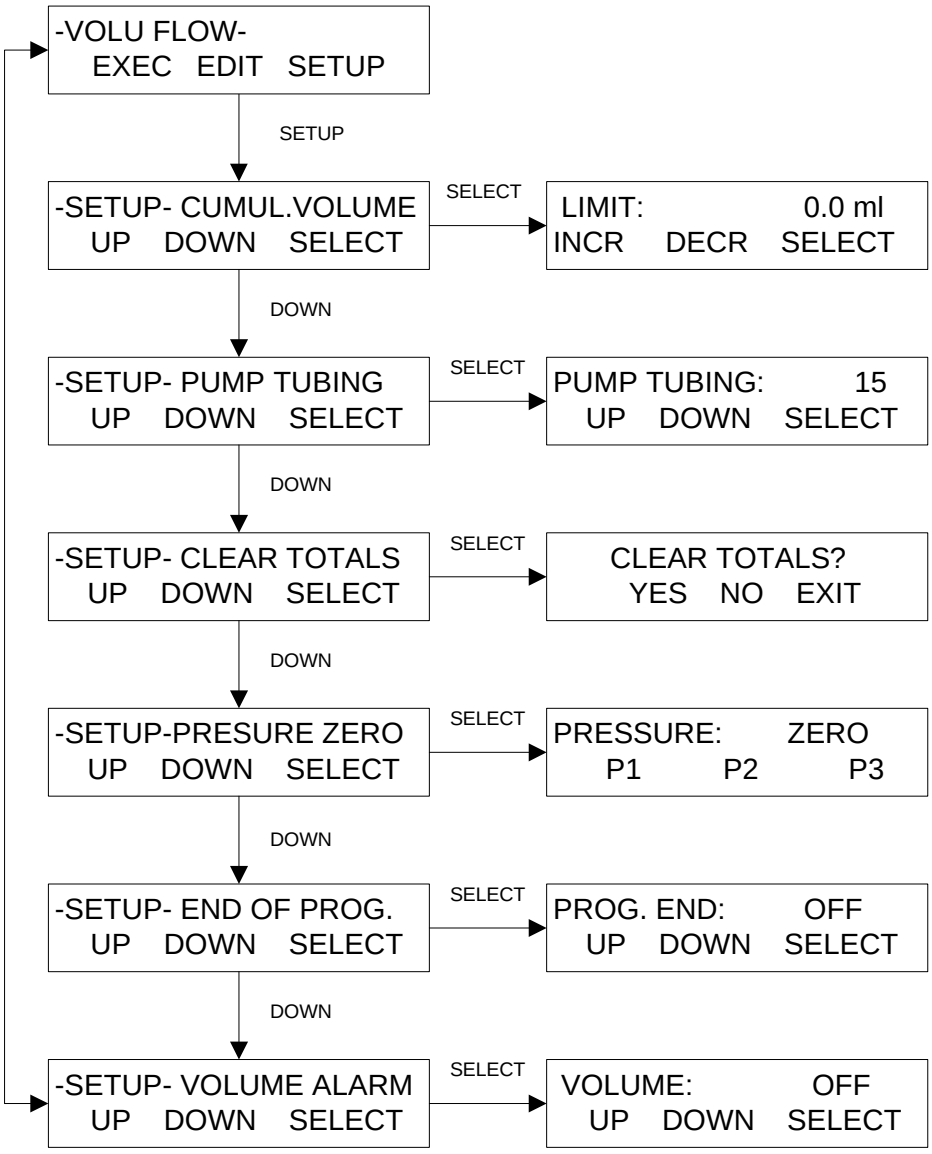
DV	250.0	AV	250.0
Incr		Decr	Select

5. DV = Dispensed Volume, or that which the ChemTec believes it has metered to this point. AV = Actual Volume. Editing of this value is done using the "Incr" and "Decr" keys. Set it to match the actual measured volume that has been collected.

   Once properly adjusted, press "Select" and the built-in flow rate curve for that particular motor / head / tubing combination has been successfully Re-Calibrated.

3.2 VOLU FLOW MODE

Setup / Alarm Limits Menu



3.2 VOLU FLOW: Setup / Alarms / Program Editing

SUMMARY: The ChemTec allows you to define several alarm conditions, two of which are set in this submenu.

The **Cumulative Volume Alarm** defines the maximum amount (in ml or µl) of solution to be metered by the ChemTec. For example, if the Cumulative Volume Alarm is set at 200 ml, then the ChemTec will sound an alarm and stop the pump when 200ml of solution have been dispensed. The **End of Program Alarm** provides an auditory signal and stops the pump action, when the user-defined program has ended.

Three options are available for each of the alarms. The alarm can be either Off, Alarm Only (auditory signal only), or Stop Pump (auditory signal and pump stops).

The remaining alarms / limits, Hi Pressure, Hi Temperature, and Hi/Lo Analog are found in their respective submenus as part of the Main Setup Mode menu

Setup / Alarm Settings:

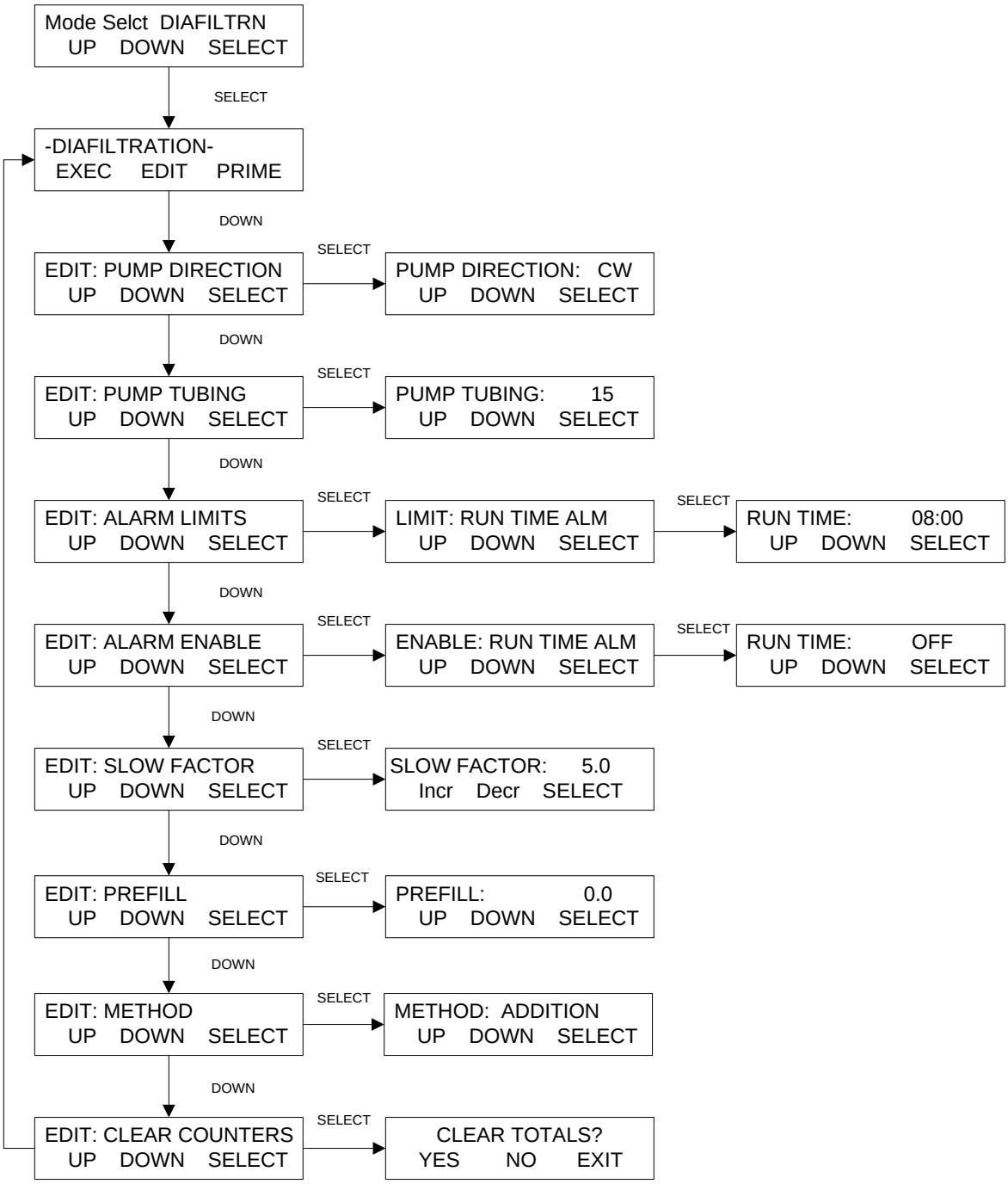
- **Cumulative Volume Limit:** Select the total volume of solution to be metered. Default = 0.0
- **Pump Tubing:** If using a Tandem peristaltic head, select the correct L/S tubing size that matches that in use. This accesses the internal calibration curves.
- **Clear Totals:** Use to clear the cumulative values. This will be prompted for this upon pressing the Exit key at the end of a run.
- **Pressure Zero:** Use this interface to zero the pressure sensor if using one. Be sure there is no pressure in the system when this is done.
- **End of Program Alarm:** Select the appropriate alarm option to be alerted when the volume flow program has come to an end.
- **Volume Alarm:** Select the appropriate alarm option for the Cumulative Volume Limit. Select one of three alarm options: Off, Alarm Only, or Pump Stop. If the Cumulative Volume Alarm is of critical importance in the application, implement the “Stop Pump” alarm option.

Program Editing:

Insertion of Program Statements: A program statement can be inserted at any point in the volume flow program by simply pressing a key or by selecting a pump function from the display. The program statement associated with a particular key will be inserted ahead of the previously displayed program statement.

Deletion of Program Statements: Except for the “START” and “END”, any displayed program statement can be deleted by pressing the “Delete” key (“B”). By pressing this key, the displayed statement is removed from your program. If you wish to insert a new statement in place of the deleted statement, press “Last” (“C”) then insert the new statement by pressing the appropriate keys.

4.0 DIAFILTRATION MODE: Edit



4.0 Diafiltration Mode: Edit

Summary: Diafiltration mode provides maintenance of a constant volume / weight of a retentate reservoir of a TFF system while permeate is continuously removed from the reservoir. As the weight on the scale is reduced, more solution is added to maintain the original weight value.

A balance or scale upon which the reservoir rests must be interfaced with the ChemTec in this mode, and the pump will respond based on the resolution of the balance. The ChemTec is almost always paired in the Diafiltration system with a PureTec, SciPro or SciPure as the TFF recirculation system.

This can also be done in a method where solution is removed from the reservoir to maintain the original weight.

Parameter selection:

- **Pump Direction:** Press select and choose between clockwise - CW (default) and counter-clockwise - CCW.

- **Pump Tubing:** Select the tubing size in use. This selection will access the internal calibration curve for that tubing size for the selected motor rpm. The Diafiltration Volume value is based upon this calibration.

- **Alarm Limits:** Used to set limits for the following Alarms: Run Time and Diafiltration Volume. These alarms are explained in the next section.

- **Alarm Enable:** Select the action of a particular Alarm: There are three choices, OFF (disabled), Alarm Only (audible alarm, system continues to run), or Pump Stop (audible alarm and the system stops). Choose settings for: Run Time, Diafiltration Volume, and Reactor Weight Alarms. These alarms are explained in the next section.

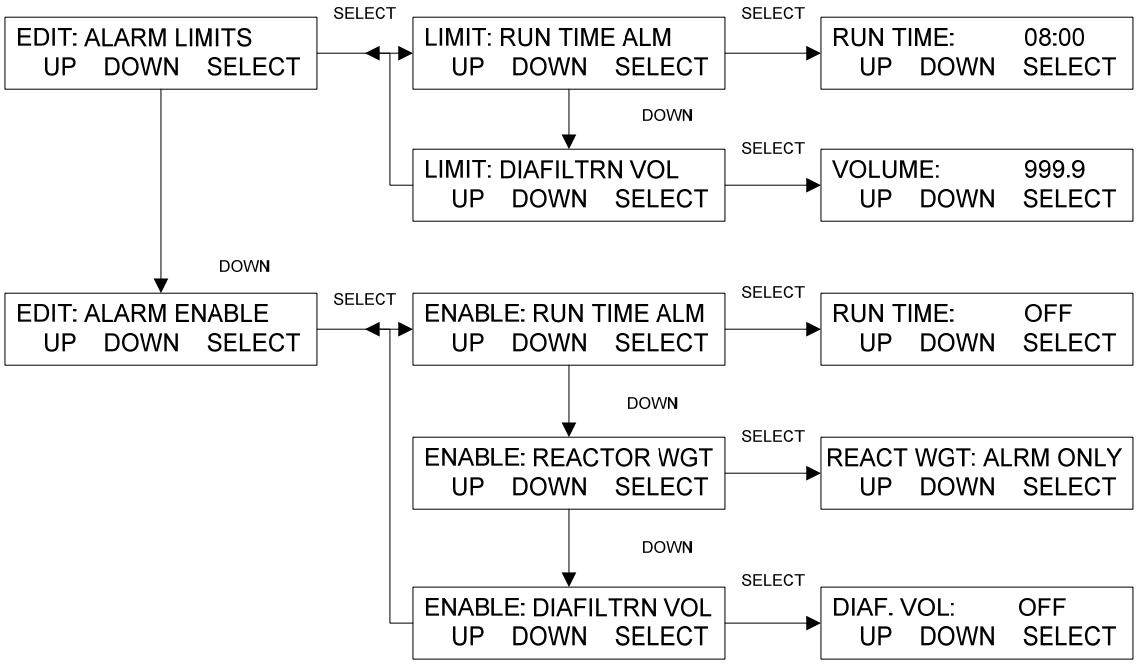
- **Slow Factor:** Slow Factor affects the speed at which the pump reacts to changes on the balance. 0.0 is the slowest response, 9.9 the fastest. Adjust as needed to avoid overshooting at high flow rates. Default = 5.0

- **Prefill:** Used to add or remove weight at the beginning of a process. The ChemTec will add or subtract that amount and possibly a bit more based the Slow Factor setting above, and then maintain the new weight value. Note that this action occurs each time the process is executed. Set to 0.0 to disable this feature. Default = 0.0

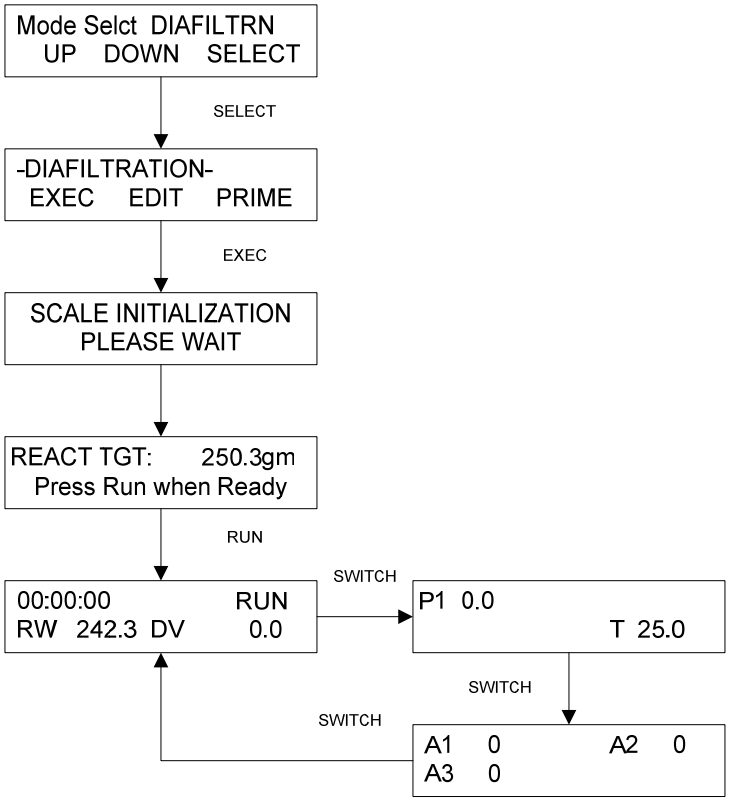
- **Method:** Choose between Addition and Subtraction. Addition adds solution to maintain the weight value; Subtraction removes solution to maintain the value. Default = Addition.

- **Clear Counters:** Used to clear the cumulative Diafiltration Volume (DV) and Run Time counters. Press select, and then Yes or No to: “Are Your Sure? “

4.1 DIAFILTRATION MODE: Alarms / Limits



4.2 DIAFILTRATION MODE: Execute Display



4.1 Diafiltration Mode: Alarms / Limits

Summary: The Diafiltration Mode has a set of three alarms, two of which are user-defined.

Alarm Enable / Alarm Limit: There are a group of three user-definable alarms, two with definable limits: Run Time, Diafiltration Volume, and Reactor Weight. The Enable menu allows you to choose from three options for each alarm: **Off** (disabled), **Beep Only** (provides audible alarm, pump still runs), or **Stop Pump** (system stops, beeps).

- **Limit: Run Time Alarm:** User defined processing "run" time. Set the desired time limit in hours:minutes. The pump will beep or stop and beep when this limit is achieved depending upon the Enable setting.

- **Limit: Diafiltration Volume:** User-defined diafiltration volume limit. Set the desired volume and the ChemTec will beep or stop based on the Enable setting. The Pump Tubing setting must be correct for this value to be accurate. The calibration of this value can be updated using Volume Flow Mode. It is not based on the balance.

- **Enable: Reactor Weight Alarm:** This alarm occurs when the ChemTec is unable to maintain the reactor weight within any given one minute period. <u>This is a critical safety alarm and should always be set at Stop Pump.</u> This alarm has no related limit.

- **Pressure and Temperature Alarms and Limits are available in their submenus as a part of Mode Select: Setup.**

4.2 Diafiltration Mode: Execute Display.

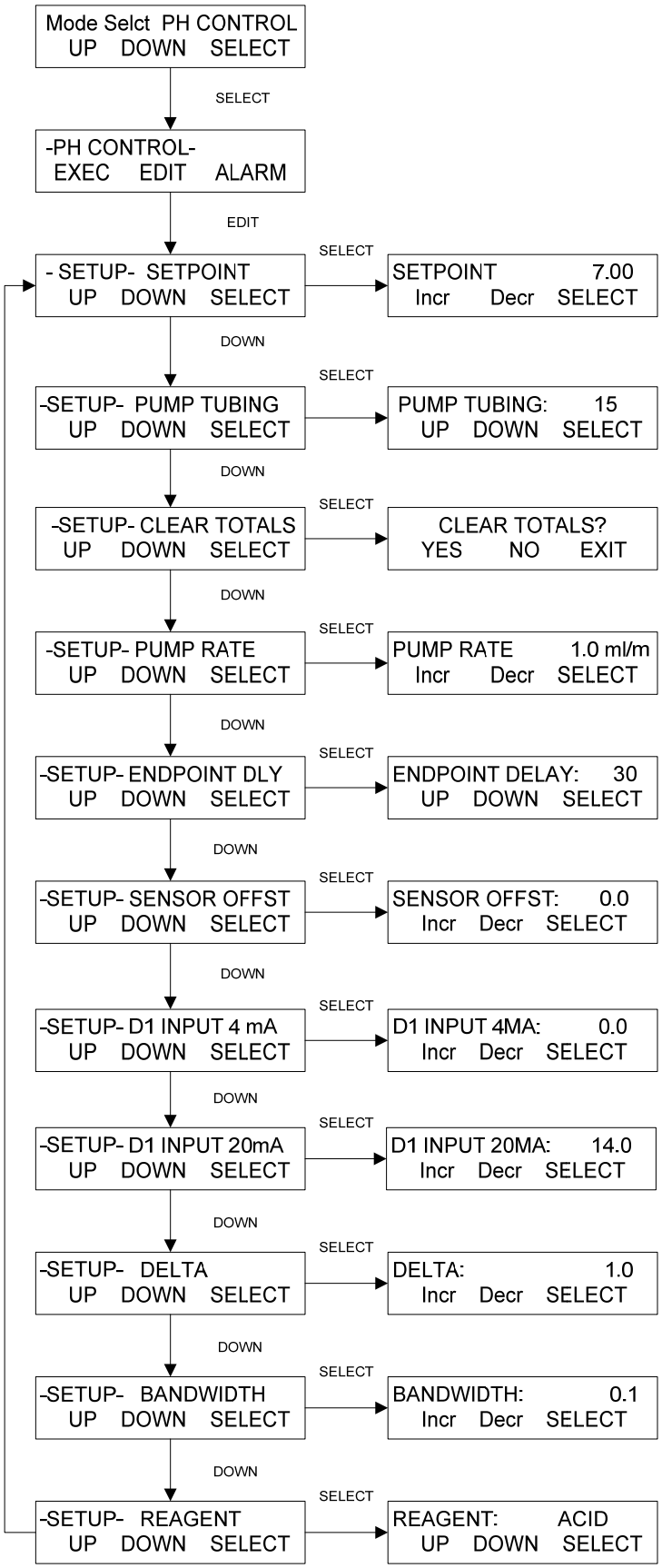
1. Press the Exec key.

2. The ChemTec will initialize the scale, and displays Relative Time (RT) in hh:mm:ss format, the pump status, (RUN) the Reactor Weight, (RW) and the Diafiltration Volume (DV).

3. Press the Run key and the Reactor Weight is captured. The unit will then maintain the rate by adding solution to the reactor as it is removed by another process. If the rate is continuous, the rates will match quite quickly, maintaining the captured weight.

4. Additional displays are accessible via the "Switch" button that show the monitored backpressure (P1) and Temperature (T) on the first screen, and the value of all three available Analog Signals (A1, A2, A3) on the second. These Analog signals may be from any sensor/transmitter, UV, Conductivity, etc. as long as it has a 4-20 ma output.

5.0 pH CONTROL MODE: Edit



5.0 pH CONTROL MODE: Edit

Summary: To achieve optimal pH control, pump rate, pH-Setpoint, pH-Bandwidth, pH-Delta, as well as Endpoint Delay must be carefully selected. The factory-set default values will provide good pH control, however, depending on the reactor volume, the Max Pump Rate, pH-Delta and Bandwidth can be further optimized.

If a particular set of parameters causes the pH-Setpoint to be exceeded, the pH-Delta should be increased and/or the max ChemTec pump rate must be decreased, i.e. smaller increments of acid or base are added to the reactor.

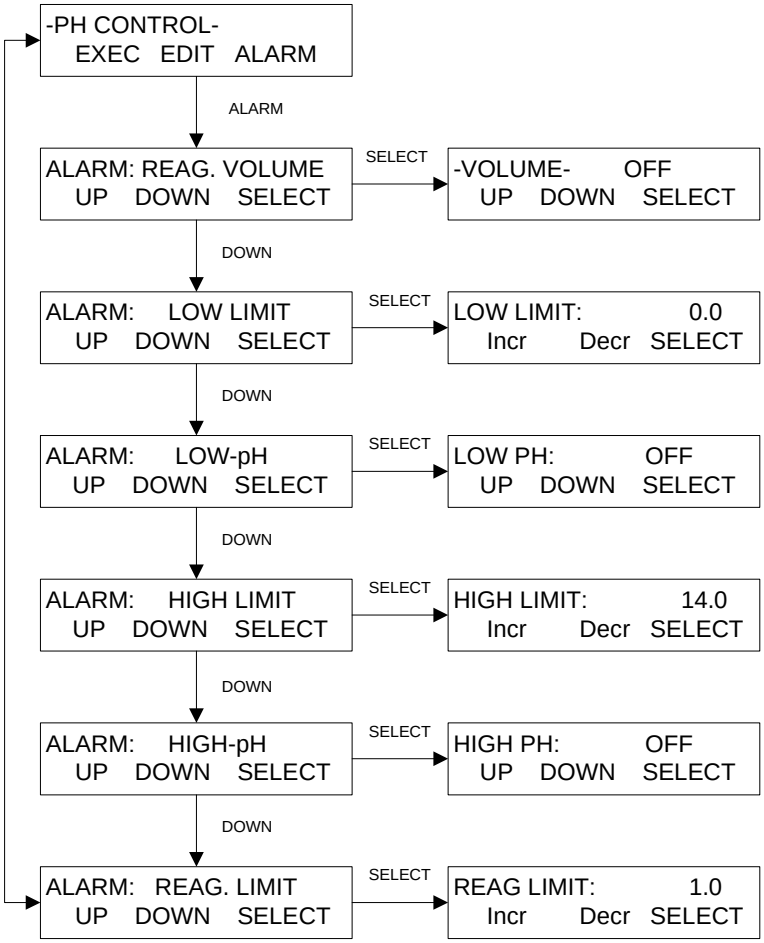
If using a peristaltic pump head, select the pump tubing that is used. For quantitative, high accuracy pH control, a pump re-calibration is recommended before initiating pH maintenance or titration. This flow rate calibration is accomplished in Volume Flow Mode.

- **Setpoint:** A single pH value between 0.00 and 14.00 is entered. This is the pH that is maintained by the ChemTec. For process titrations, the Setpoint is the titration endpoint, e.g. pH = 7.00 for simple acid /base neutralization.
- **Pump Tubing:** Select a pump tubing size that can accommodate the desired pump rate. Refer to the chart on the side of the ChemTec for flow rate ranges with different tubing / motor sizes. Default = 15.
- **Pump Rate:** This is the maximum reagent addition rate. Range depends upon motor/tubing combination in use. Default = 1.0 ml/min.
- **Endpoint Delay:** The Endpoint Delay should be used with Endpoint titrations. The Endpoint Delay represents the time period in seconds during which a constant Setpoint must be maintained. If the pH has not sufficiently stabilized during the Endpoint Delay period because of incomplete mixing, the pump may turn on again and deliver additional small aliquots of reagent. The Endpoint Delay will be reset when the additions occur during the Endpoint Delay period. The titration has been successfully completed with the expiration of the Endpoint Delay.

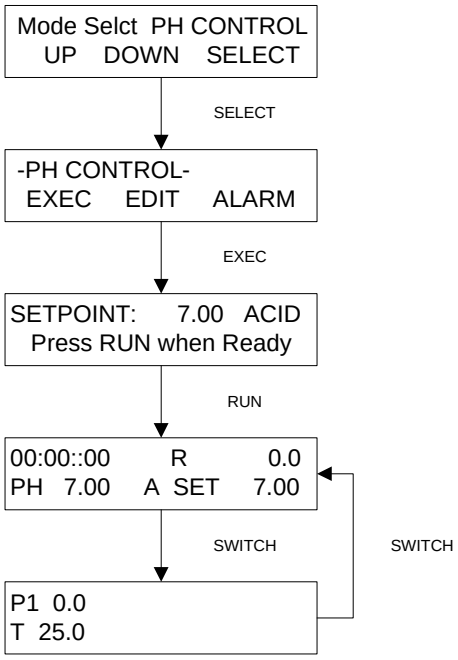
For pH maintenance, the Endpoint Delay should be set to 0.0. With this setting the Setpoint will be maintained indefinitely within a 0.1pH unit range, i.e. the smallest pH-Bandwidth.

- **Sensor Offset:** Represents the pH difference displayed on the pH Meter versus the pH displayed by the ChemTec. Typically, a small offset is shown that can be eliminated by increasing the Sensor Offset from +/- 0.5 pH units.
- **D1 INPUT 4mA:** Enter the low pH (typically pH = 0.0) that represents the low end of you pH range. If you use the expanded scale on your pH meter, enter the low pH value of the expanded scale that generates a 4mA pH-meter output.
- **D1 INPUT 20mA:** Enter the high pH value (typically pH = 14.00) that represents the high end of your pH range. If you use the expanded scale on your pH meter, enter the high pH value of the expanded scale that generates a 20mA pH-meter output.
- **DELTA:** Represents the pH range (default: DELTA = 1.00) during which the pump speed is automatically reduced from the initial PUMP RATE setting. The DELTA value should be increased or the pump rate should be decreased if the SETPOINT is repeatedly exceeded during titration. Example: Setpoint 7.0, Delta 4.0 yeilds a max flow at pH 11.0 which reduces until within Bandwidth of Setpoint.
- **BANDWIDTH:** The Bandwidth setting determines how far the solution pH can deviate from the SETPOINT before the ChemTec starts delivering reagent.
- **REAGENT:** Either ACID or BASE must be selected.

5.1 pH CONTROL Mode: Alarm / Limits Menu



5.2 PH CONTROL MODE: Execute Display



5.1 pH CONTROL Mode: Alarms / Limits

- **REAGENT VOLUME ALARM:** Select either “Off” (Default), “Alarm Only”, or “Pump Stop”. These are the three (3) options that can be selected. This setting is used in conjunction with “REAGENT LIMIT” below. The REAGENT VOLUME LIMIT / ALARM is very useful when a specific reagent volume is to be dispensed. The ChemTec will automatically stop once the REAGENT VOLUME LIMIT has been reached if set to Pump Stop.
- **LOW-pH LIMIT:** Enter the value for the LOW-pH LIMIT. Default = 0.0. The alarm is triggered when the pH drops below this value. This setting is used in conjunction with the LOW-pH Alarm.
- **LOW-pH ALARM:** Select either “Off” (Default), “Alarm Only”, or “Pump Stop”.
- **HIGH-pH LIMIT:** Enter the value for the LOW-pH LIMIT. Default = 14.0. The alarm is triggered when the pH rises above this value. This setting is used in conjunction with the HIGH-pH Alarm.
- **HIGH-pH ALARM:** Select either “Off” (Default), “Alarm Only”, or “Pump Stop”.
- **REAGENT LIMIT:** Enter the reagent volume to be dispensed, i.e. 45 ml. When used together with the REAGENT VOLUME ALARM, the ChemTec will stop automatically when the reagent limit has been achieved.

- **Pressure and Temperature Alarms and Limits are available in their submenus as a part of Mode Select: Setup.**

5.2 pH CONTROL Mode, Execute Display

1. Press EXEC and the Setpoint and Reagent chosen are displayed.

2. The ChemTec will initialize the process and displays Relative Time (RT) in hh:mm:ss format, the Reagent Volume (R), the measured pH value (PH), the Reagent chosen (A for Acid, B for Base), and the Setpoint value. (SET).

3. An additional display is accessible via the “Switch” button that shows the monitored backpressure (P1) and Temperature (T).

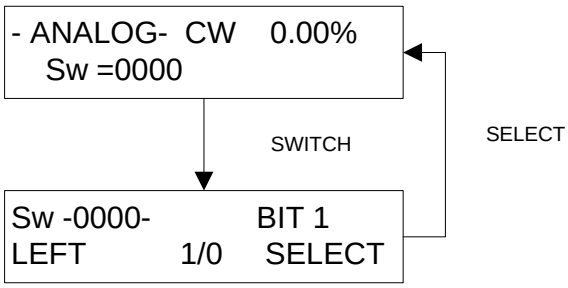
6.0 ANALOG Mode:

Summary: Analog mode allows direct proportional control of the ChemTec motor as a percent of motor speed from a 4-20 mA analog input signal on Analog Channel 1. The pump direction, % of motor speed, and status of the TTL switches is displayed.

The following front panel keys are active in Analog Mode: RUN, STOP, CW/CCW, and SWITCH.

The SWITCH key provides access to four TTL switches. Use 1/0 to change the state and the LEFT button to change Bits from 1 – 4 to select the switch to change.

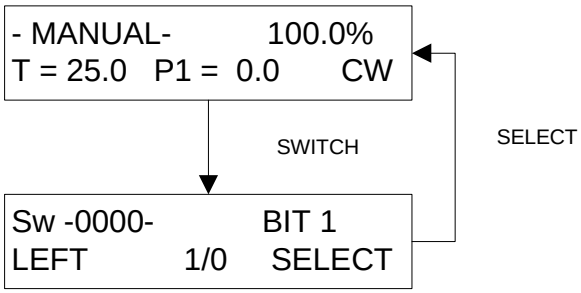
The unit can be controlled using this signal and the RUN and STOP buttons, or via an External Run/Stop cable. (Requires setting Ext Run-Stop in Setup: Pump to Level.)



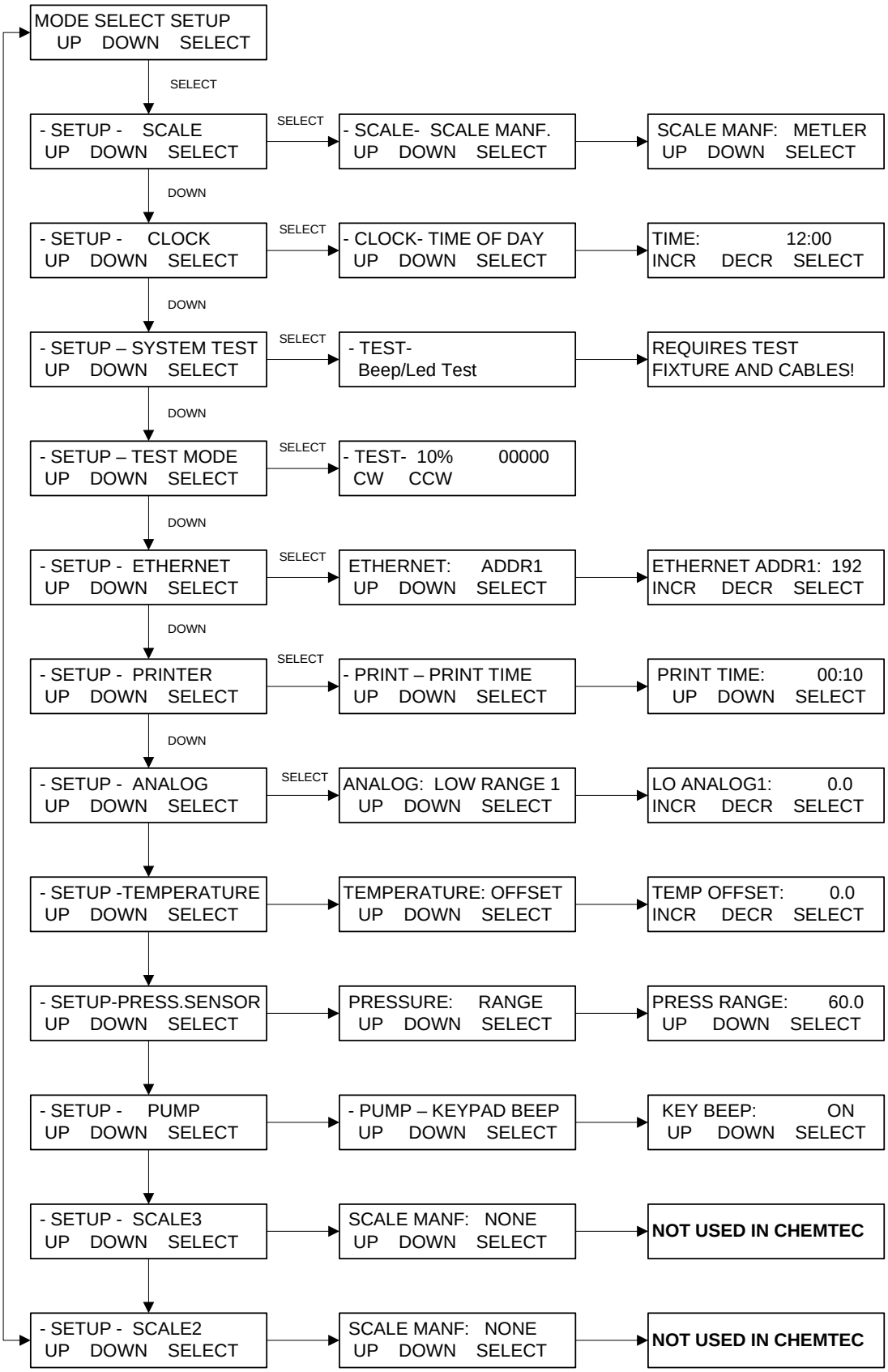
7.0 Manual Mode:

Summary: This mode allows manual control of the ChemTec. The following front panel keys are active in Manual Mode: RUN, STOP, RATE, CW/CCW, and SWITCH. The RATE key allows you to change the pump speed, while the SWITCH key provides access to four TTL switches.

The screen displays the Mode, the % of Motor speed that is set, the status of the TTL switches, the Pressure if a sensor is in use, Temperature in ºC and the pump direction.



8.0 SETUP



8.0 SETUP Mode:

Summary: The Setup Menu consists of the following items; the following sections provide further explanation:

Scale: Proper Scale communications are set by selecting the correct Scale Manuf. Scales from Mettler, Ohaus or Sartorius may be used. Submenu allows setting of Scale Manuf., Units, Alarm, and Tare. Default = "Metler".

Clock: Set the time of day (military), **day**, **month**, and **year**. **Print Enable** allows choice of Relative (Run) Time, or Time of Day for printout and display. In most cases the clock will be set at the factory for the destination time zone. Default = Relative Time.

System Test: Allows testing of the ChemTec I/O's, requires purchase of IQ/OQ Document. Use Test Mode if needed for trouble shooting.

Test Mode: Allows independent testing of the ChemTec I/O's. Motor, Keypad, Scale, Pressure, Temperature, Valves, Analog, TTL switches.

Ethernet: Allows setting of the IP Address, Subnet Mask and Gateway values for Modbus TCP/IP communication via the Ethernet Port.

Printer: Select communications parameters for SciLog printer (P/N 080-095) or PC. Default settings are **Print Time** (Default = 10 sec.), **Type** (Seiko), **Baud Rate** (9600), **Stop Bits** (2), **Parity** (None), **Word Length** (8), **Print Delay** (0 sec).

Analog: Allows setting of Hi and Lo Range, as well as Hi and Lo Limits, Alarms and Zeroing of all three available 4-20 ma analog inputs.

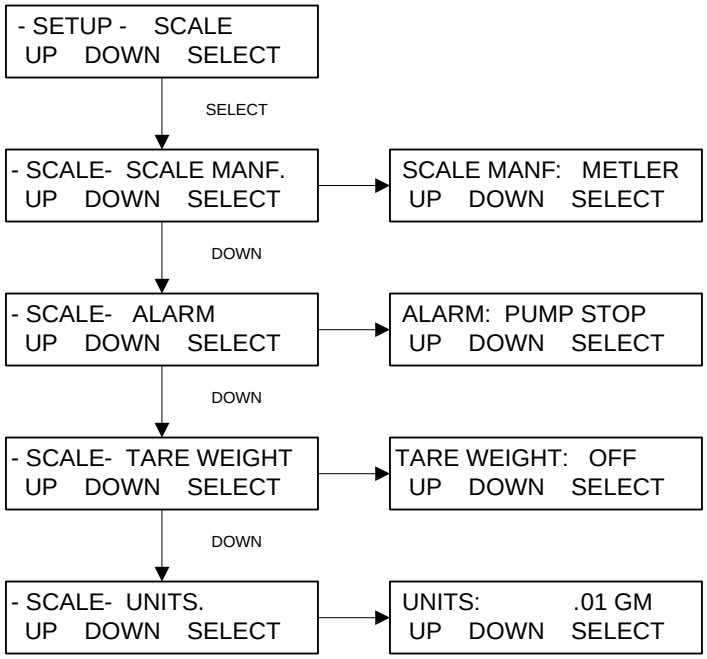
Temperature: Select an Offset for the SciTemp Temperature sensor if needed.

Press. Sensor: Allows user to **Zero** all three SciPres pressure sensors. (**Span** is used for factory calibration.) **Source** is used to select the desired sensor for related alarms and control in all modes. **Units**: Choose from Psi (default), Bar, or Kpa. **Range:** Default is 60, can be set lower, will require re-calibration of the input. Contact SciLog Customer Service for assistance..

Pump: Select the following user preferences: **Keypad Beep:** (On/Off), **Switch Configuration:** (Level / Pulse), **Switch Polarity:** (Normal/Inverted), **TTL1:On-Off:** (Yes/No), Set Yes if controlling another pump as a slave, set NO if controlling Rotary Selector Valve "W". **Motor Start:** (Hard / Soft-Ramp), **Motor RPM:** (3400, 600, 160, 8), **Pump Head:** (Peristaltic/RH1/RH0/RH00), **Pump Tubing:** (13/14/16/25/17/18/15/24/35), **Power Up:** (Mode/Menu/Run), **External Run-Stop:** (Pulse/Level), **ASCII Feedback** (On / Off), **Factory Reset:** (Resets all variable parameters to their original factory defaults).

Scale2 and Scale3: Not utilized with the ChemTec. Must remain set to "None". Do not remove the covers.

8.1 Setup: Scale



- **Scale Manuf:** Select the appropriate value for the scale in use. Options: Ohaus, Ohaus2, Ohaus3, Mettler, Metler2, Sartor, Sartor2. Default = Metler. Proper configuration of the scales parameters is required, as well as correct interface cable.

    - Ohaus3: Adventurer Pro.
    - Ohaus2: Adventurer, Explorer, Explorer Pro.
    - Mettler: Viper, Series 4, IND560.
    - Metler2: Speedweigh, Panther.
    - Sartor2: Current default Sartorius setting, all series.

- **Alarm:** Triggered if communication with the scale is lost. Options: Pump Stop, Alarm Only or Off. Default = Pump Stop.

- **Tare Weight:** Determines if the system tares the scale upon pressing Execute and Run in the main operational modes. This is counterintuitive. Options: On, Off. Default = OFF, which causes the system to tare the scale. ON will cause the tare to not occur.

- **Units:** Select from: .001 gm, .01 gm, 0.1 gm, Kg, T, Lbs, OzT, Oz, C, Dwt. Default = .01 gm.

A Mettler Toledo BBA422 series scale is the most frequently purchased scale sent with the system. If a different scale is required, please contact SciLog for configuration information.

8.11 Mettler Toledo BBA/BBK 422 Scale Parameters:

To enter the Technical Setup mode, press and hold the "Print" key until the word **CODE** appears on the display. Then press "Zero", "Tare", "Zero", "Tare", "Print", and the word **SCALE** will appear. You are at the top of the menu. Use the "Zero" and "Tare" buttons to scroll thru choices on a level, and the "Print" button to select.

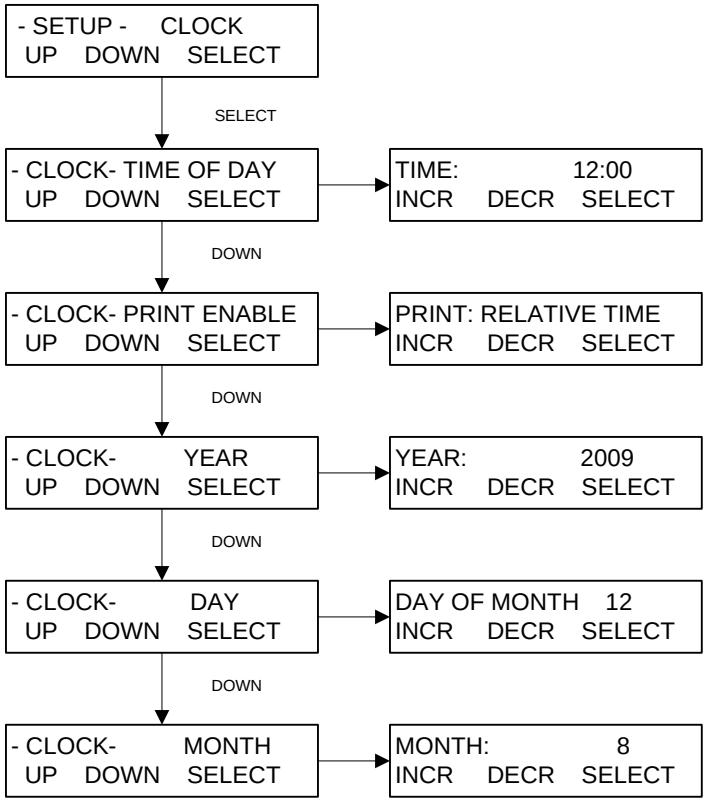
Menu Level 1	Level 2	Level 3	Selected Menu Item	
SCALE	Display	Unit1	g	
		Unit2	**g**	
	Tare			
	Zero	**AZM**	**OFF**	
	Restart			
	Filter	Vibrat	Medium	(High)
		Process	Universal	(Dosing)
		Stabili	Standard	(Fast)
	Fact			
	Min.Weig			
	Reset			
APPLIC				
TERMINL				
COMMUNI	COM1	**Mode**	**Dial.old**	
		Paramet	Baud	9600
			Parity	8 none
			H.Shake	**NO**
	Option			
	Def. Prn			
DIAGNOS				
END				

NOTE: The **Bold** parameters are the only custom settings needed for communication with SciLog systems. Those in ( ) are options. All others should remain at factory defaults. Consult your scale manual for help navigating through the scale menu.

In Setup Mode, select "**METLER**", see **SETUP: SCALE: MANUF.** By making this selection, the system will implement the correct parameters for communicating with this scale. You will also need SciLog P/N 080-067PGS Mettler Balance-Pump Interface Cable

Scales purchased with the system through SciLog will be configured and tested together with the ChemTec as a system at the factory.

8.2 Setup: Clock



Clock is used to set the Date and Time in the ChemTec real time clock, and control the displayed and output time format.

- **Time of Day:** Press Select and use the Incr. and Decr. buttons to set the current time in 24 hour format. This should be preset by the factory prior to shipping.

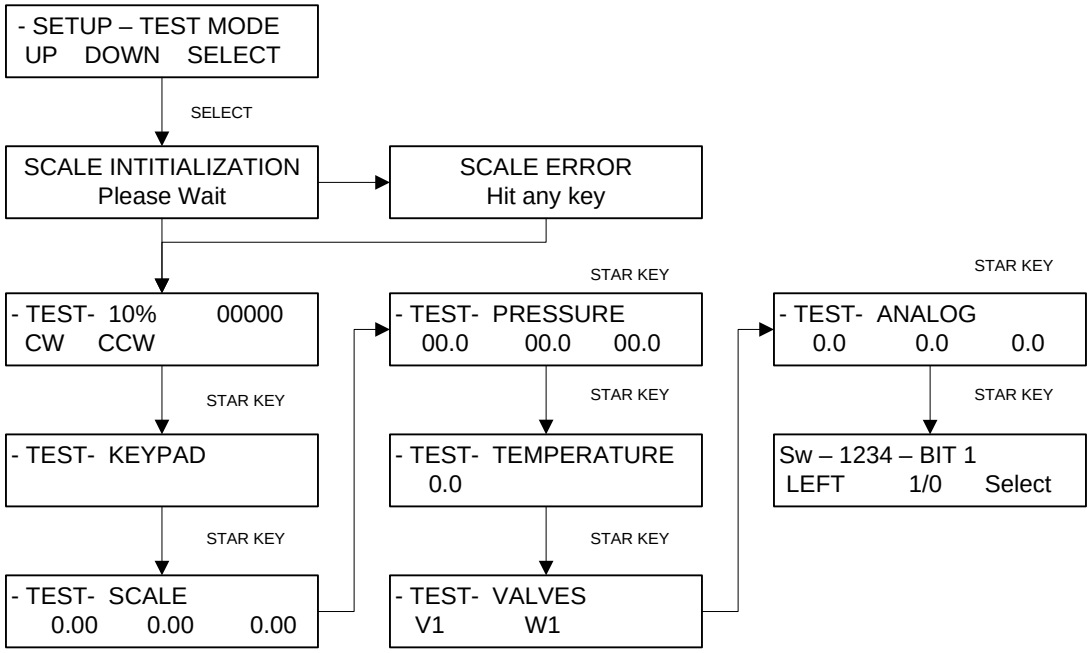
- **Print Enable:** Controls displayed and output time. Choose between Relative Time and Time of Day. Relative Time starts at 00:00:00 at the beginning of a processing run, and Time of Day yields current time. Default = Relative Time.

- **Year:** Press Select and use Incr. and Decr. to set the current year.

- **Day of Month:** Press Select and use Incr. and Decr. to set the current day of the month.

- **Month**: Press Select and use Incr. and Decr. to set the current month.

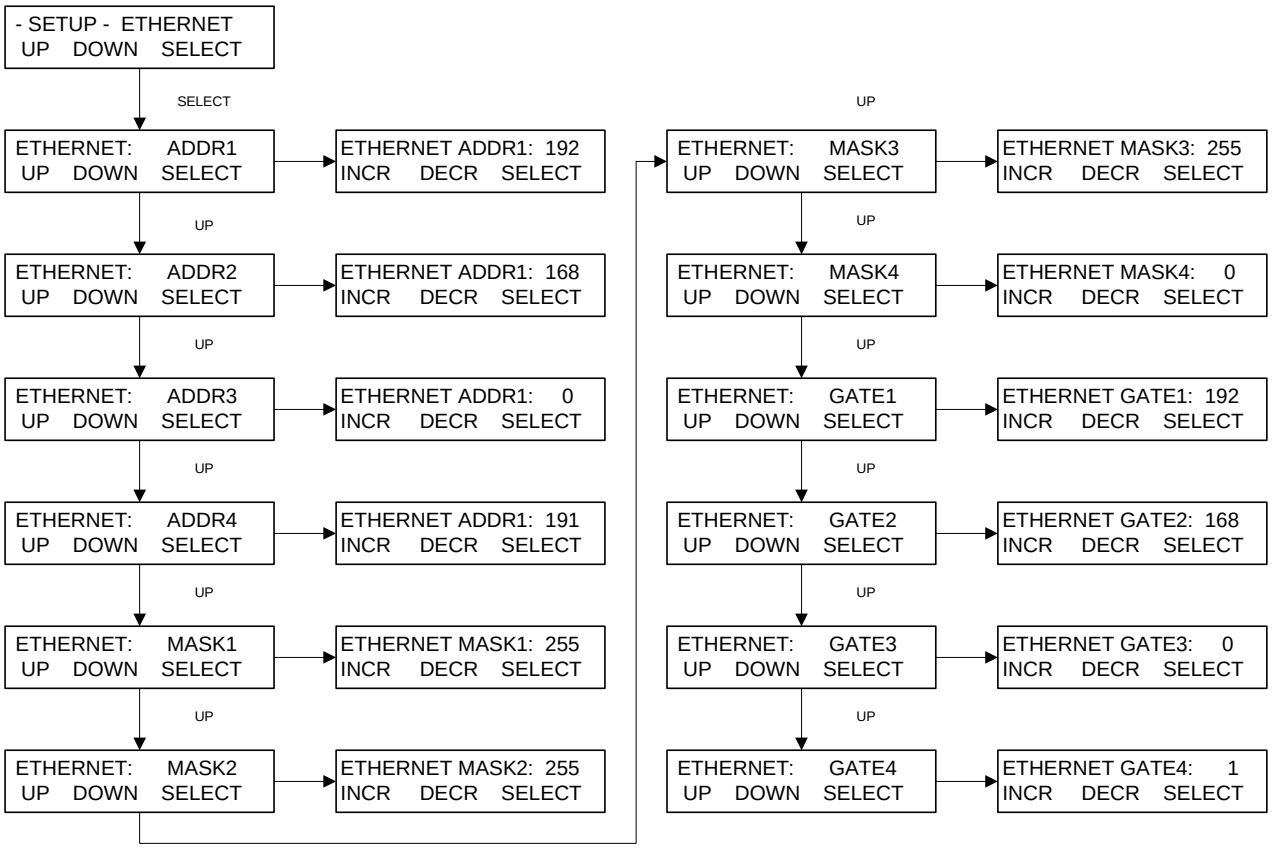
8.3 Setup: Test Mode:



Test Mode provides the ability to test the inputs and outputs (I/O's) of the ChemTec outside of the normal operational modes. Upon pressing Select, the ChemTec will attempt Scale Initialization. If it passes, the next Test appears. If it fails, press any key and the next Test appears. Use the Star (*) button to move between tests.

- **Motor**: This tests the motor. Use the Rate/Pressure button to change the motor speed. Use the Run / Stop buttons, and the CW / CCW keys to exercise the motor. The encoder pulses/second is displayed.
- **Keypad**: This tests the keypad. Press the buttons in any order, and an appropriate number is displayed. Left to right, top to bottom, they are numbered 1 through 0, the Star key passes if it moves to the next test.
- **Scale**: If a scale is connected and is communicating properly, the value here will match that of the scale. (There are three shown, due to the three interfaces, but only one is used with the FilterTec.)
- **Pressure**: If SciPres Disposable Pressure Sensors are connected, they will display the measured pressure, P1, P2, P3. By pressing the A, B, or C keys, the sensors may be zeroed. If there is no sensor connected, **--.-** will be displayed.
- **Temperature**: If a SciTemp Disposable Pressure Sensor is connected, the measured temperature in ºC will be displayed. If no sensor is connected, 0.0 is displayed.
- **Valves**: If Valve V or W is connected, press the A or B button to test them.
- **Analog**: Displays the analog value for Channels 1, 2 and 3 based upon input and Hi/Lo range settings.
- **TTL Switches:** By using Left and 1/0 to change the BIT setting, the TTL outputs may be tested. You must have a DMM connected to measure the voltage, it will be 0.0 if Switch is set to 0, and 5.0 Vdc if set to 1. (display is 1234 if all are high, 0000 if all are low)

8.4 Setup: Ethernet



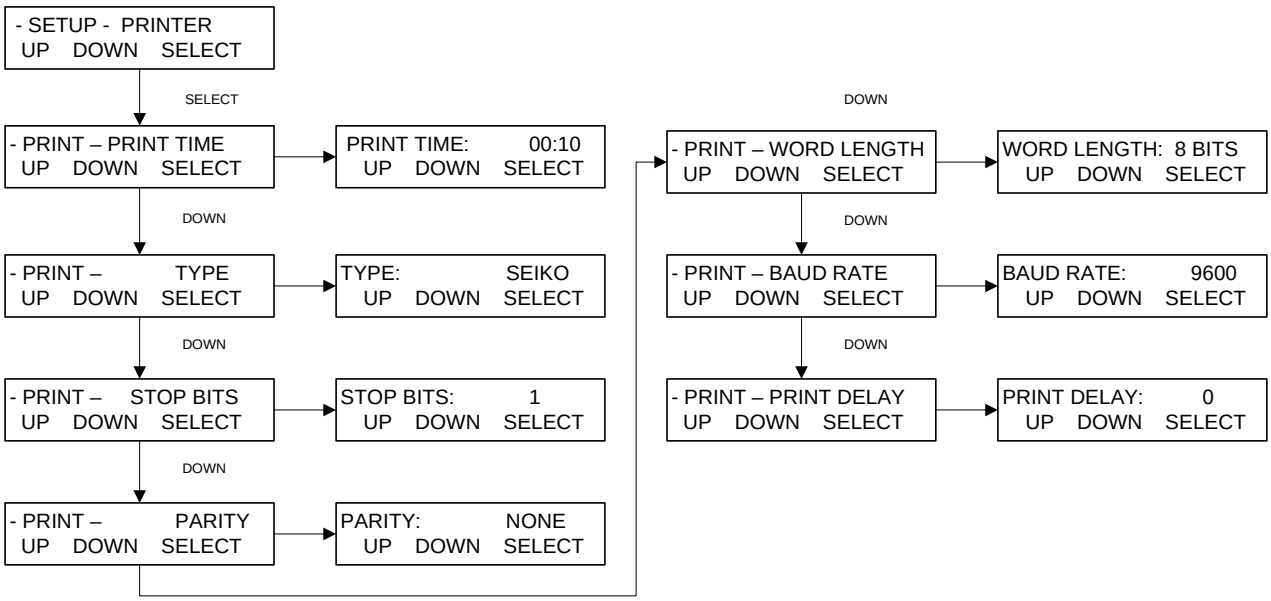
Ethernet allows setting of the IP Address, Subnet Mask and Gateway for the ChemTec. This allows communicating with the ChemTec via Modbus TCP/IP when it becomes available. Initially, if set properly for the company network, the user can ping the unit from a command prompt. Consult the company Network Administrator for the proper settings. A crossover cable can be used if connected directly to a PC, otherwise use a standard network patch cable and a hub or switch.

- **IP Address:** The default IP Address for the ChemTec is 192.168.0.191. Use ADDR1 through ADDR4 to modify this address.

- **Subnet Mask:** The default Subnet Mask is 255.255.255.0. Use MASK1 through Mask4 to modify this address.

- **Gateway:** The default Gateway is 192.168.0.1. Use GATE1 through GATE4 to modify this address.

8.5 Setup: Printer



Printer allows the setting of RS-232 communication parameters needed for connection to a SciLog serial printer or to a PC for data collection.

- **Print Time:** Controls how fast the ChemTec sends data points in Minutes: Seconds. Maximum is 30:00 minutes; Minimum is 00:05 seconds. Default = 05:00 minutes.

- **Type:** Allows use of two styles of small serial printers, Seiko, a thermal unit, and Starr, a dot matrix. For all other printers, and PC communication, Seiko setting is used and is the default.

- **Stop Bits:** Select 1 or 2. Default = 1.

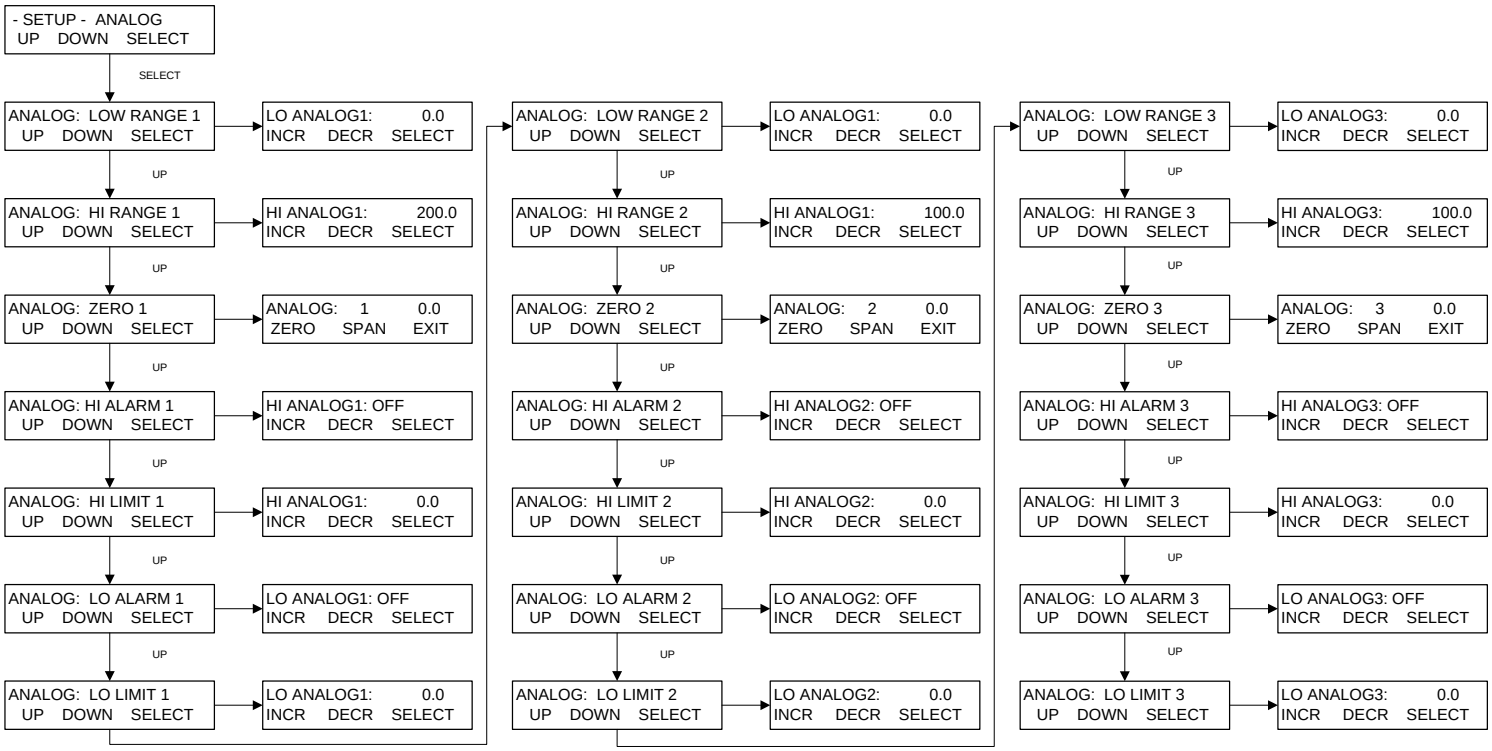
- **Parity:** Select Even, Odd or None. Default = None.

- **Word Length:** Select 7 or 8 Bits. Default = 8 Bits.

- **Baud Rate:** Select 300, 600, 1200, 2400, 4800, 9600, or 38.4. Default = 9600

- **Print Delay:** Used to slow down the output for printers with small buffers. Select 0 – 5 seconds. Default = 0 seconds.

8.6 Setup: Analog

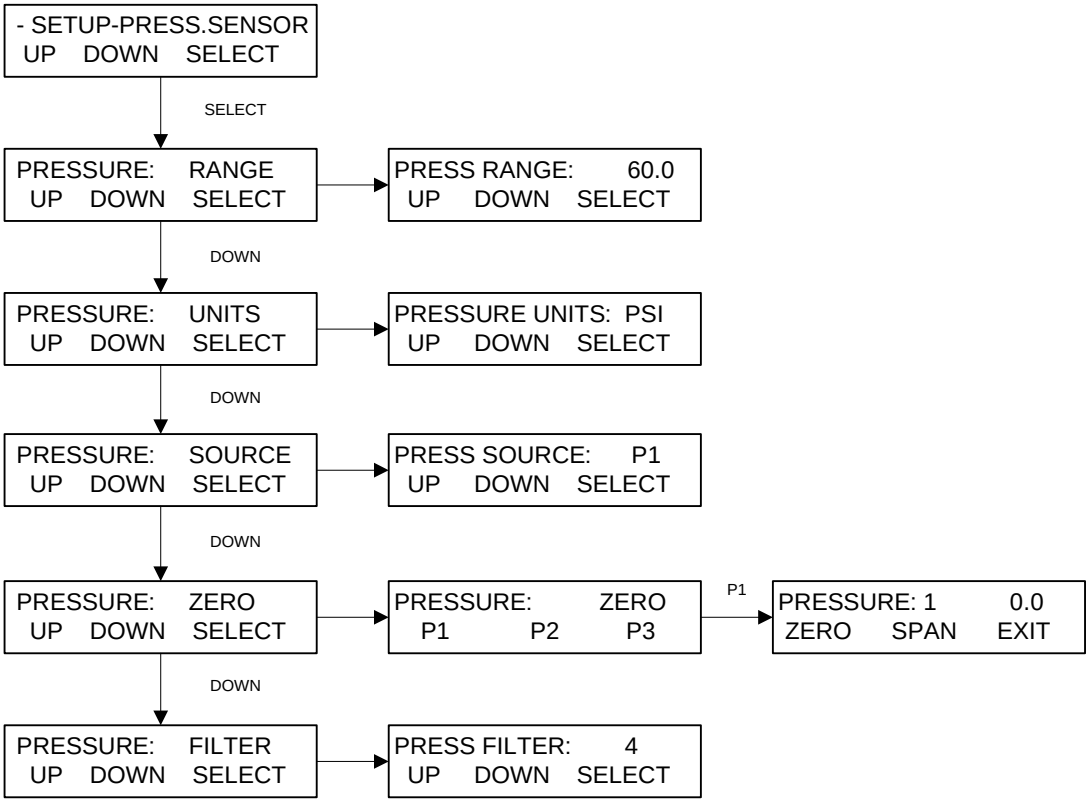


Analog provides for configuration of the three available 4-20 mA Analog inputs. The Hi/Lo Range values can be set, the signal can be calibrated via a Zero/Span function, and Hi/Lo Alarms and Limits can be set for any or all three of the inputs.

- **Lo Range 1:** Set the value for the 4 mA input on Channel 1. Default = 0.0
- **Hi Range 1:** Set the value for the 20 mA input on Channel 1. Default = 200.0
- **Zero 1:** Provides for calibration of the Analog Channel 1 input. Provide a 4 mA signal and press "Zero". Provide a 20 mA signal and press "Span". Press Exit to finish. The device being interfaced or a source traceable to NIST should be used for this procedure.
- **Hi Alarm 1:** Choose the enable setting for a Hi Alarm on Channel 1. Select between Off, Alarm Only and Pump Stop. Default = OFF
- **Hi Limit 1:** Set the Limit for Hi Alarm 1. The alarm is triggered when the value is exceeded. Default = 0.0
- **Lo Alarm 1:** Choose the enable setting for a Lo Alarm on Channel 1. Select between Off, Alarm Only and Pump Stop. Default = OFF
- **Lo Limit 1:** Set the Limit for Lo Alarm 1. The alarm is triggered when the value drops below the limit after first exceeding it. Default = 0.0

- **Note:** Analog input channels 2 and 3 are the same, except the default for the Hi Range is 100.0. Maximum range value for any channel is 9999.9.

8.7 Setup: Pressure Sensor



Pressure Sensor is used to configure settings related to the SciPres Disposable Pressure Sensors. The following can be configured; Range, Units, Source (control and alarms), Filter (signal noise) and Zero/Span. The ChemTec uses only one sensor port, choice is made with the Source setting below.

- **Range:** Set the overall pressure range, the Default is 60.0 psi, and is the maximum. Changing this setting requires re-calibration of the sensor signals.

- **Units:** Select between Psi, Bar, and KPA. Default = Psi.

- **Source:** Controls the source pressure sensor for monitoring and alarms. Select between P1, P2 or P3. Default = P1

- **Zero:** Used to "Zero" the sensors to establish the zero offset cause by the circuitry and any inherent hydraulic pressure in your tubing beyond the pump head. Connect the sensor, and remove any pressure from the system. Select the sensor, P1, P2 or P3 and press "Zero". You are prompted to confirm the action. "Span" should not be used on a routine basis, as it sets the max input value. NOTE: Do not Zero P1, P2 or P3 unless a sensor is connected. The display should read "--.-" with no sensor connected. If it reads 0.0 in this state, connect the sensor and re-zero it.

- **Filter:** This feature filters out the pulsations in the pressure signal due to the peristaltic nature of the pump head. This provides better control and easier to read values, as well as improved graphed data. Select from 1 to 7, 1 = no signal filter, 7 = maximum filter. Default = 4.

8.7 Setup: Pressure Sensor, Calibration

The ChemTec has built in calibration curves for the SciPres disposable pressure sensors that are inherently very accurate for the installed default range of 0 – 60 psi, and there should be no need for you to change it. If your metrology department insists that they calibrate them periodically, the procedure follows.

To calibrate the ChemTec / SciPres Disposable Sensors:

1. Obtain a NIST traceable regulated source of compressed gas (i.e. air, nitrogen) and pressure gauge.

2. Go to Mode Select; Setup; Pressure Sensor, then to Pressure: Range, and note the range specified, change if desired. (Default is 60 psi.)

3. Press Exit and scroll to Pressure: Zero.

4. Choose P1.

5. With no pressure on the sensor, press Zero ("A" button).

6. Connect regulated pressure source to P1, and carefully increase to match range noted in step 2.

7. **Note**: Pressurizing the SciPres Sensors beyond 60 psi can damage the sensor.

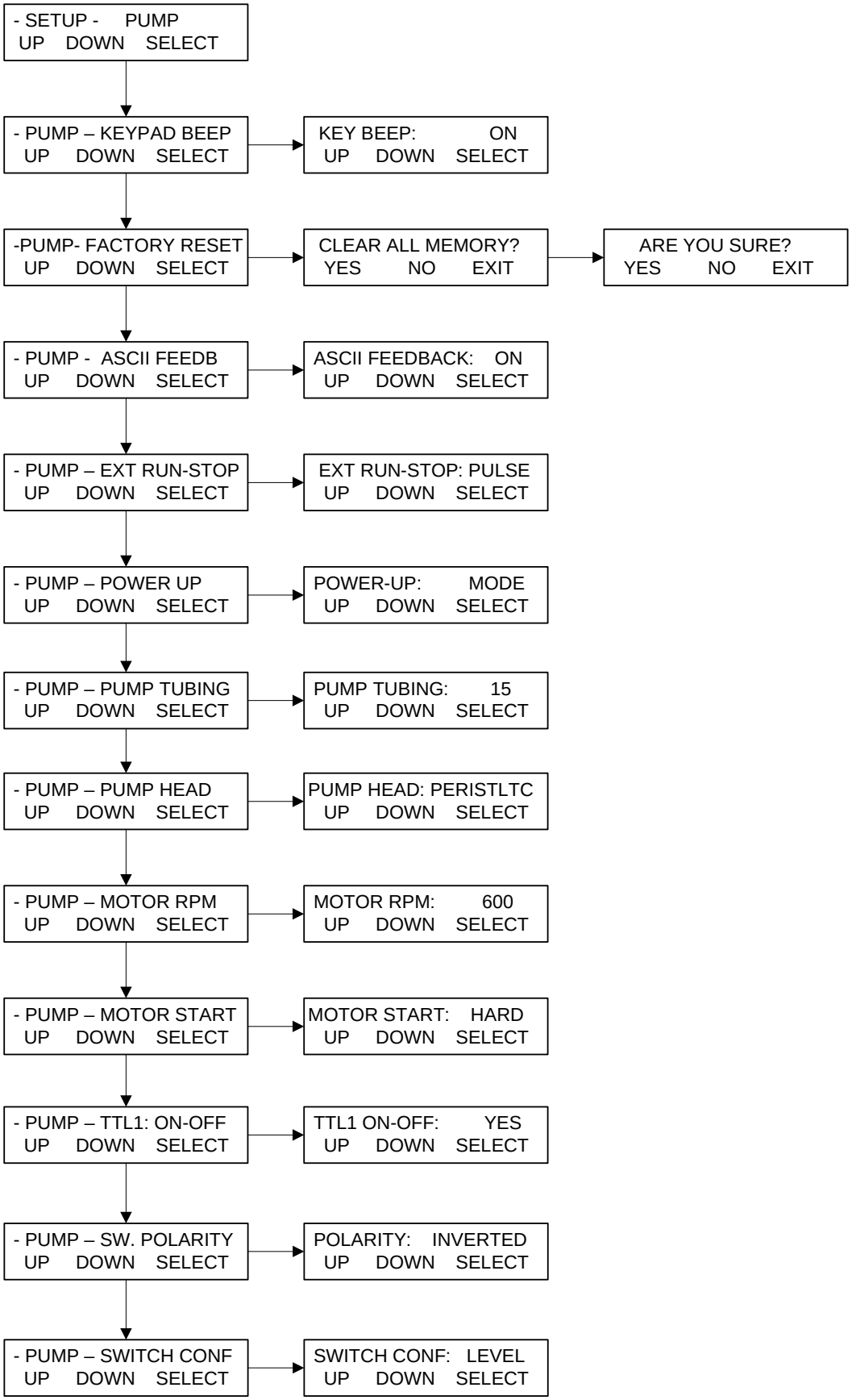
8. Press Span ("B" button).

9. Turn off pressure source, Press exit.

10. Repeat steps 5 – 8, choosing P2 and then P3.

11. You have now recalibrated (spanned) all 3 SciPres sensors. It is still advisable to zero each sensor again with no pressure in the system, prior to running your tests via the Edit: Press. Sensor menu in the operating mode of choice.

8.8 Setup: Pump



8.8 Setup: Pump:

Setup: Pump provides configuration of global settings related to the pump. Generally, the default values here do not need to be changed. Any changes required for a particular system will be made at the factory, and would only need to be modified if a "Factory Reset" is performed.

- **Keypad Beep:** Determines if the buttons "beep" when pressed. Default = ON.
- **Factory Reset:** Resets the system to the factory default settings for all menus. Requires pressing "YES" to both the "Clear All Memory?" and "Are You Sure?" prompts.
- **ASCII Feedback:** Controls responses sent to a PC upon receipt of a remote command. Default = ON.
- **External Run-Stop:** Controls action of the Footswitch connection, which is part of the External I/O DB37 connector (pins 19 and 37). Choose Pulse for footswitch type control where the contacts are closed and then opened. Choose Level for contact closure control where closed = Run and open = Stop. Run key is disabled when this is set to Level except in Manual Mode. Default = Pulse.
- **Power-Up:** Controls the action of the system upon power-up. Choose from Menu, Mode, or Run. Menu = the system returns to the top of the Menu. Mode = the system returns to the last Mode it was in. Run = the system returns to the last Mode it was in and starts the process.
- **Pump Tubing:** If Pump Head is set to Peristaltic, all nine standard tubing sizes can be chosen. Used with Motor RPM setting to determine proper calibration curve. Default = 15.
- **Pump Head:** Choose between Peristaltic, RH1, RH0, RH00, Mag 201, Mag 122, Mag 120, and Mag 040. Used to access the proper calibration curve. Default = Peristaltic.
- **Motor RPM:** Choose between 8, 160, 600 and 3400 rpm, matching the motor installed in the system. This will be set at the factory. It will need to be reset after a Factory Reset if other than the default. Default = 600.
- **Motor Start:** Controls how fast the motor starts. Hard is fast, Soft is slow. Default = Hard.
- **TTL 1 On-Off:** Controls action of TTL Switch 1, used for Master/Slave control of another system or device with TTL input control. Set to Yes, TTL 1 changes states from High to Low when the system is told to run the motor. Set to No, it does not. Default = Yes.
- **Switch Polarity:** Controls the polarity of the TTL switches. Inverted = High when not activated, Low when activated. Normal = Low when not activated, High when activated. Default = Inverted to allow for proper Master/Slave control.
- **Switch Configuration:** Sets the action of the TTL switches. Choose between Level and Pulse. Default = Pulse. Set to Level to allow for proper Master/Slave control.

9.0 Data Acquisition:

Summary: SciLog has available a software package called SciDoc that includes data collection software and a Custom Excel spreadsheet that is automatically populated when any of the modes are executed except Manual. It also has charts that are automatically populated as the data is generated. See Section 9.1 below.

Either the Printer Port or USB Port may be used for data collection. The instructions for installing the USB driver appear at the beginning of this manual. The ChemTec Printer Port is required for use with a SciLog serial printer, and both Thermal and Dot Matrix are available. By using both ports, the data can be simultaneously captured on a PC and a Printer.

When a PC is connected, all data generated in Mass Flow, Volu Flow, Diafiltration and pH-Control modes can be sent to the PC for archiving. Manual and Analog Modes generate no data output. Please use the SciLog SciDoc Data Collection Software described below. Alternatively, a PC running “HyperTerminal”, a program that comes with Windows, may be used to capture the data. The HyperTerminal settings are provided for you in section 7.2 entitled “PC HyperTerminal Settings.” When interfacing with a PC you will need a separate RS-232 cable (P/N: 080-073) or USB cable (P/N: 090-158).

Note: For a successful hook-up with your PC, the ChemTec and the PC must use the same communications protocol. Make sure that the communication parameters in Setup: Printer are the same as those listed in for HyperTerminal below or the default values.

The ChemTec is also equipped with a USB port that can be connected to your PC. You will find the driver for this connection on the CD this manual came on. You will need to look in Device Manager on your PC to determine the Com Port number assigned to the ChemTec.

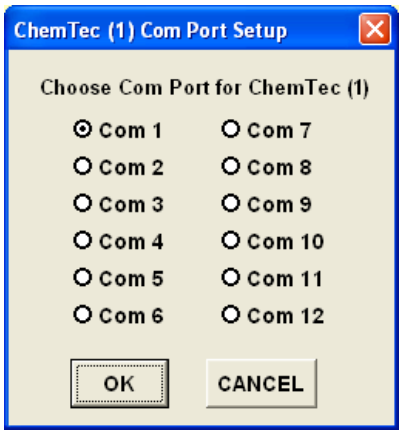
The system is also equipped with an Ethernet Port. Settings for the Ethernet connection are described in section 8.4. This is for communication via Modbus TCP/IP, and when the register list is available, it will be added to the manual as an appendix.

9.1 ChemTec SciDoc Data Collection Software:

SciDoc is a software package that captures the data output of the ChemTec and places it in an Excel spreadsheet. This spreadsheet also populates several graphs to aid you in the analysis of your process. It consists of a copy of WinWedge32 from TalTech Inc. and a custom spreadsheet with built in macros. It requires the use of a SciLog RS-232 cable, (P/N: 080-073) or USB cable, (P/N: 090-158) to connect your FilterTec to an available Com Port on your PC.

Minimum system requirements for are Windows 98 and Excel 2000. WinWedge32 v3.4 is included in the package and is Vista compatible. Installation instructions are included with the package.

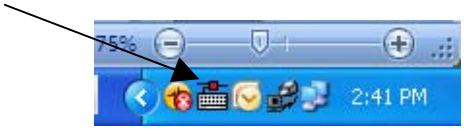
Once installed, click on the shortcut for the spreadsheet, and the following dialog box is presented:



If you do not get this screen, you will need to change the Macro Security settings in Excel.
If it does not prompt to enable macros or does not prompt for the COM port, the security level is too high.

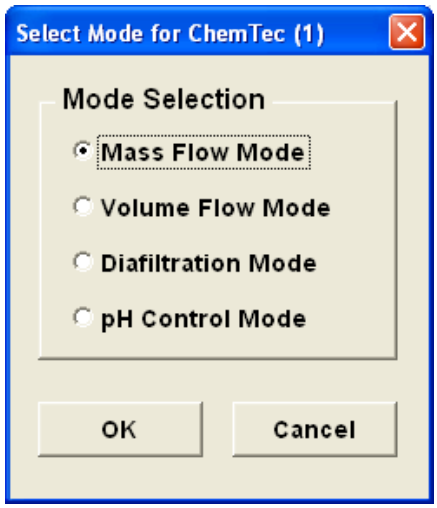
1. If using a version of Office older than 2007, from the Excel menu bar, click on Tools, Macros, and Security. Set it to Medium, close the spreadsheet and re-launch it.
2. If using Office 2007, from the Excel window, click on the Office logo in the upper left corner. Then click on Excel Options in the lower left of this window. Highlight the Trust Center, and click on Trust Center Settings in the lower left.
    a. In this window you have two options:
        i. Click on Trusted Locations, then Add new location, browsing to the Winwedge folder where the spreadsheet is located and making it a trusted location.
        ii. Click on Macro Settings, and choose Enable all macros.

Choose the Com Port the ChemTec is connected to. Click on the OK button and WinWedge32 will start, showing itself as an icon in the system tray.

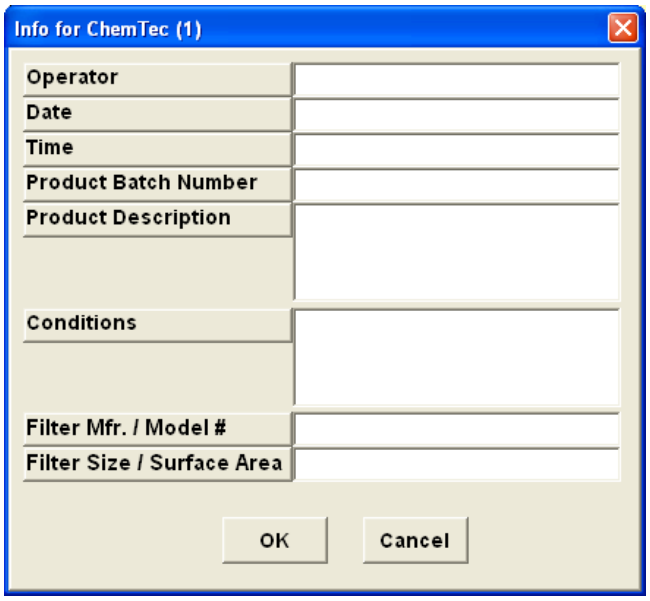


If you chose cancel on the Setup dialog box, WinWedge32 won't be in the system tray, and you will need to click on the "Com Port Setup" button to complete this task in order for data collection to be possible. Once this is complete, you will have the next dialog box:

This dialog box allows the user to setup the spreadsheet to correctly deal with the data from Mass Flow, Volume Flow, Diafiltration and pH Control Modes:

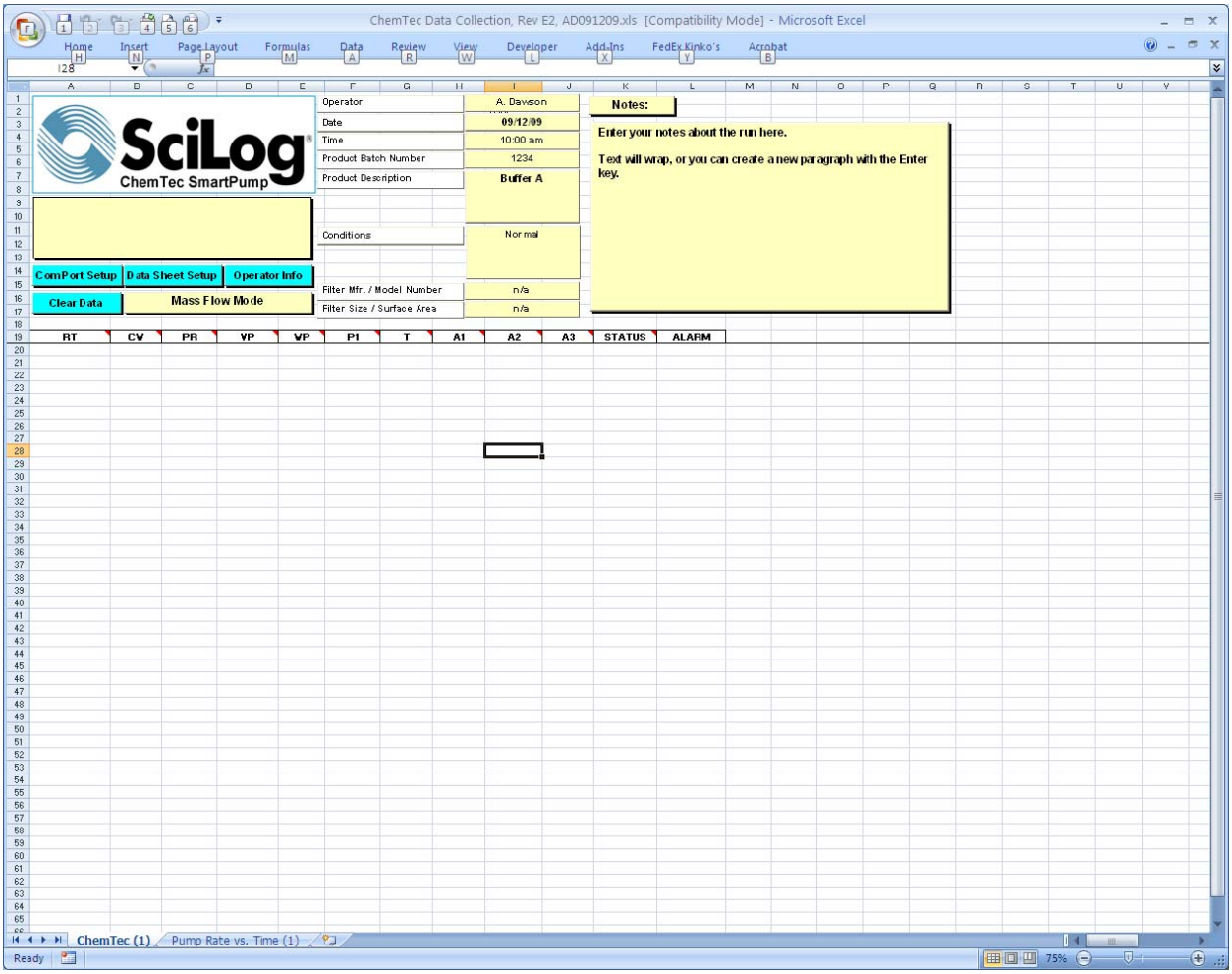


After pressing the ok button, the next dialog appears:



Enter the operator's information and press OK.

After pressing OK, the empty datasheet appears:



When ready, press EXEC on the ChemTec, and then RUN after the balance has initialized.

The spreadsheet automatically captures the data at intervals defined by the Print Time setting in the Setup: Printer sub menu. The columns and headers that are visible are dependent upon the operational Mode of the ChemTec, and the mode selected on the Data Sheet setup screen. It is important that they match, or some data may be hidden.

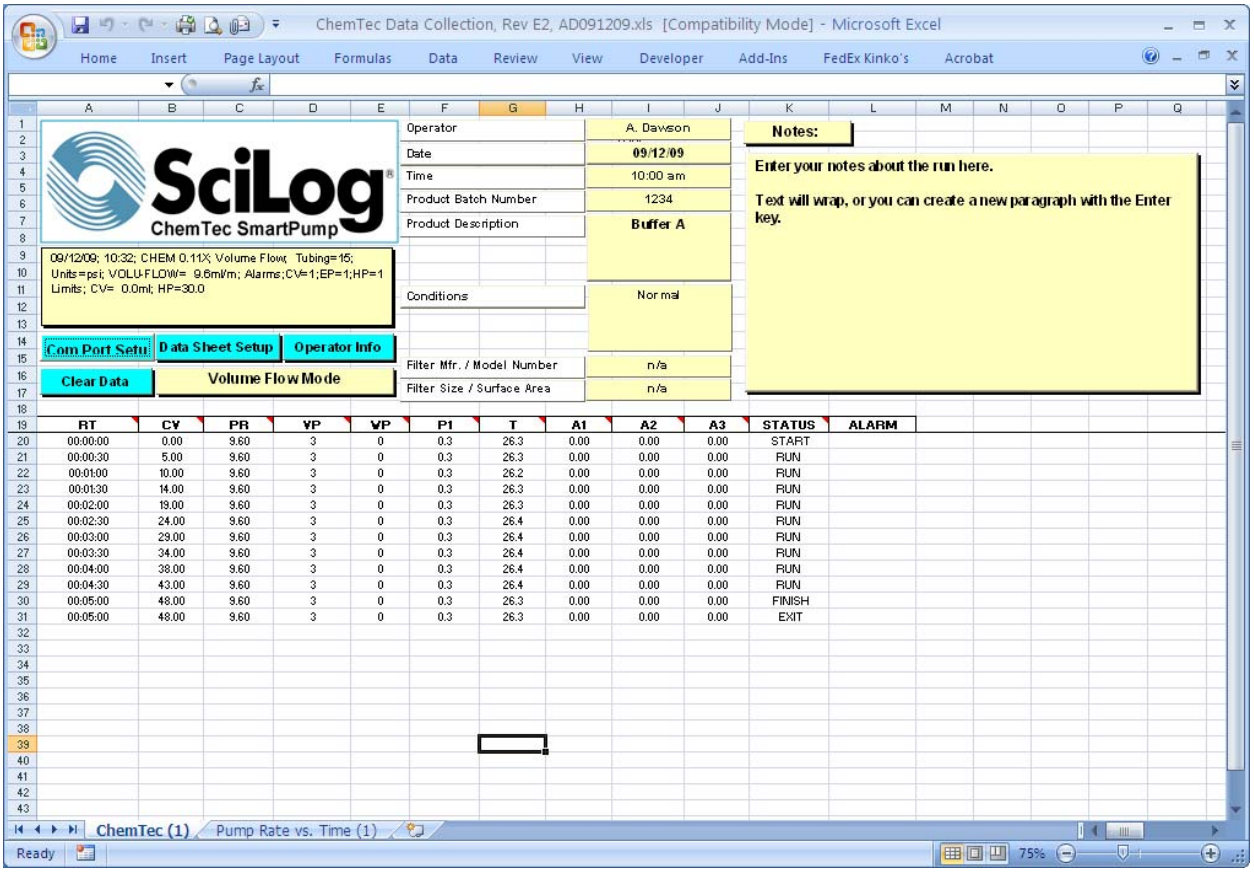
The data generated will automatically be placed in the cells of the spreadsheet, and the charts populated with the same data. The text box in the upper left of the spreadsheet contains the header information that is generated by the ChemTec. This will list the Operational Mode, the date and time, all operating parameters, alarm settings and alarm limits.

The following chart is included for use, and they may be viewed by clicking on the appropriate tab at the bottom of the worksheet:

Pump Rate (PR) vs. Time

Other charts may be created, or the existing charts may be modified if needed.

When you are finished with a run, your screen will look similar to this one:



Abbreviations:

RT = Relative Time	PR = Pump Rate
DV = Diafiltration Volume (Diafiltration Mode)	CV = Cumulative Volume (Volume Flow Mode)
RV = Reagent Volume (pH Control Mode)	CW = Cumulative Weight (Mass Flow Mode)
P1 = Pressure, psi	A2 = Analog Signal 2
A1 = Analog Signal 1	A3 = Analog Signal 3
ST = Pump Status	pH = pH Units, 0-14
VP = Position of Valve V	WP = Position of Valve W
AL = Alarm (HP) HP = High Pressure (1=OFF, 2=Alarm Only, 3=Pump Stop)	EP = End of Program, HI = High pH, LO = Low pH
CW = Clockwise Pump Direction	CCW = Counter Clockwise Pump Direction

Click on File-Save as: and choose an appropriate file name based on your needs. When ready for another run, simply press the “Clear Data” button, or close and re-open the file.

Please note the following:

You may use the **STOP** key on the ChemTec front panel to interrupt the metering process. This shows up in the data set by displaying the word STOP in the ST (Status) column of the Data worksheet.

Using the **EXIT** key however and then pressing Exec and RUN again in the same data collection run, will replace the header information in the text box at the top of the worksheet, while continuing to add data to the bottom of the sheet. While the spreadsheet will pick up on any change that has occurred, the initial header information will be lost. It is recommended that you either save the data as mentioned above, or dispose of it by clicking on the "Clear Data" button prior to pressing the Exec and RUN keys again to begin a new set of data.

To open the saved data at a later time and not lose any information, click on "Disable Macros" when the spreadsheet is opened.

Please contact SciLog Inc. at 800-955-1993 if you require technical support for this software package. We welcome your suggestions regarding this software as well.

While the ChemTec and all other SciLog Smart Pumps are 21CFR11 compliant, this documentation software is not, and its results will need to be incorporated into your compliant documentation system if your situation requires it.

9.2 Uploading/Downloading of Programs

You can use Win95/98 HyperTerminal for uploading or downloading of ChemTec programs. Use the enclosed instructions for accessing the HyperTerminal in your PC and for selecting Terminal mode parameters.

Once you have HyperTerminal open, reduce the HyperTerminal window to one half of its original size. Open Note Pad ("Accessories" or "New Text Document" in HyperTerminal) and reduce the Note Pad window to one half its size. Note Pad is used here as a text editor. Place the HyperTerminal window in the upper half of the monitor and the Note Pad window in the lower half of the monitor. Both are now displayed and are readily accessible.

Downloading a program from the ChemTec to the PC: place the cursor at the top of the HyperTerminal screen and type the letter **"D"** to start downloading. You should see a "Downloading" message on the pump display during transfer. The ChemTec program will appear on the HyperTerminal window.

To edit the downloaded program, highlight all program steps with the mouse, then select "Copy" from HyperTerminal, Edit. Place the cursor into the Note Pad screen and select "Paste" from Note Pad. Edit. The ChemTec program will now appear in the Note Pad window. Edit the program by deleting or adding program steps or changing the values of program parameters. The modified program can now be sent to the ChemTec by using the "upload" instructions.

Uploading a program from the PC to the ChemTec is equally straight-forward: Create a program in the in Note Pad, make sure the first line of the program is a upper case "U"; the last line of the program must be "End". Each program statement must be followed by a carriage return ("Enter"). The list as whole must be followed by an extra carriage return, and it must be included in the Uploaded text. For example:

U	Initiates Uploading
START	Starts Program
CW	Pump turns clockwise
RUN	Pump motor turns On
RATE 10.0	Pump Rate: ml/min, gm/min.
TIME 00:05	Run Time: 5 minutes
STOP	Pump Motor stops
COUNT 001	Program runs once***.***
END	End of Program

Highlight all program steps including the final extra carriage return. Select "Copy" in Note Pad, Edit, then select "Paste to Host" in HyperTerminal, Edit. An "Uploading" message should be seen on the ChemTec display during transfer. (If the program is short, look quick!)

- If an Upload occurs while the ChemTec is in the "Exec, Edit, Alarm" screen, the program will be loaded into the ChemTec but will not be executed.
- If the Upload occurs while in the "Press RUN when Ready" screen, the ChemTec will start the program once the upload is complete.
- If the Upload occurs while a ChemTec program is running, the pump will stop, the scale (if used) is re-initialized and the tare is activated. After the balance tares, the newly uploaded program starts at the beginning.

9.3 Win95/98 HyperTerminal Settings:

ChemTec to PC: For PC Connections via the Printer Port a SciLog RS-232 Cable (P/N: 080-073) is needed. When not using the SciLog printer, this allows process data to be "dumped" into a PC for archiving. The list of settings below must match those in Setup: Printer of the FilterTec, and Print Delay should be set to "0". Alternatively, the USB port may be used. The driver for the USB connection is on the CD this manual is on, and may be downloaded from www.scilog.com.

The following terminal setting procedure is intended for PCs with a **Window 98/XP** software installation: Press the **START** button in the lower left corner of your screen, select **"Programs"** then select and open **"Accessories",** select **"Hyper Terminal".**

If using **Vista**, HyperTerminal Personal Edition can be downloaded from the internet at: http://www.hilgraeve.com/hyperterminal.html

From the **"Connection Description"** screen, select an icon and enter a file name, i.e. ChemTec. **Press "Ok"**
From the **"Connect To"** screen, select **"Direct to Com 1"** in the box labeled "Connect Using" or the Com Port assigned to the FilterTec and **Press "Ok".**

From the **"Com 1 Property"** screen, select the following parameters

Bits per Second:	9600
Data Bits:	8
Parity:	None
Stop Bits:	1
Flow Control:	None

Press "Ok"

Press "Ok" at the bottom of the "ChemTec Setup" screen.

A window with a blinking cursor will be presented, and the data stream from the ChemTec will be displayed as it occurs.

ChemTec Program Statements:

The following control statements are used both in the Mass Flow and Volume Flow modes:

START Starts program, automatically added as 1st program statement

CW Clockwise motor direction, use “CW/CCW” key.

CCW Counter-clockwise motor direction, use “CW/CCW” key.

RUN Starts pump motor, use “RUN” key.

STOP Stops pump motor, use “STOP” key.

RATE xx.x Pump rate, g/min in Mass Flow, ml/min. in Volu Flow. Use “RATE” key.

TIME 00:00 Run Time, **hours : minutes**, last statement in timing block, all preceding statements are executed at the beginning of timing block. Use TIME key.

Sw BITS 0000 Sets Status of TTL switches 1-4. Either a 0 or a 1. Allows programmed control of external device or another pump. Use the “SWITCH” Key.

VALVE V1 Rotary Valve “V”, can select from position V1 through V6, use Star (*) key.

VALVE W1 Rotary Valve “W”, can select from position W1 through W6, use Star (*) key.

INTRP xx.x Pump Ramp (Interpolation Function), defines highest pump rate of ramp. Use the Star (*) key, and must be followed by a TIME statement defining the ramping time interval.

COUNT Defines how often the program will be repeated, typically COUNT = 1, i.e. preceding program is run once. Use Star (*) key. Note: Nested Count commands are not allowed. This only functions at the end of the program.

END End of program, automatically added as last line in program.

ChemTec Program Examples:

The first example is a simple program. When executed, the program will run the system at 10 ml/min. for five minutes then stop. Enter this program in Volu Flow, Edit**.**

```
001    START
002    CW
003    RUN
004    RATE: 10 ml/min.
005    TIME: 00:05
006    STOP
007    COUNT:1
008    END
```

The same program can also be entered and executed in the Mass Flow mode. In this case the RATE = 10 gm/min. When operating in the Mass Flow mode, a scale must be connected to the ChemTec via the S1 scale port.

The next program shows the use of timing blocks and rate / ramp statements:

```
001    START
002    CW
003    RUN
004    RATE: 10 ml/min      Pump runs at 10 ml/m for 5 minutes.
005    TIME 00:05
006    INTRP: 50 ml/min     Pump ramps from 10 to 50 ml/min in 5 min.
007    TIME: 00:05
008    RATE: 50 ml/min.     Pump runs at 50 ml/m for 2 minutes.
009    TIME 00:02
010    STOP
011    COUNT        1
012    END
```

This program consists of 3 timing blocks. The pump initially runs at 10 ml/min. for 5 minutes then ramps up to 50 ml/min over a 5-minute time interval and maintains a pump rate of 50 ml/min for 2 minutes.

By leaving out line 005 TIME 00:05, the system would immediately begin the ramp from 10 to 50 instead of running for five minutes before beginning the ramp.

ChemTec™ Metering Applications

1.0 Bioreactor Feed Application: General Information

Linear and exponential feeding strategies are very useful in many bioreactor applications. The ChemTec allows the user to readily implement such nutrient metering strategies. The following examples outline some general approaches; however, the specific pump rates and feeding intervals must be experimentally determined and are dependent on the specifics of the process, i.e. type of organism, rate of bio-mass growth, bioreactor size, etc. Once the optimal feeding rate and feeding interval have been determined, the appropriate feeding strategy can be readily automated with the ChemTec, utilizing either a volumetric or a mass-flow metering program.

Volumetric metering is recommended for applications in which the feeding intervals are relatively short. Here, the pump tube wear of the peristaltic pump is the main limitation to metering accuracy. Thus, longer feeding intervals may require frequent pump re-calibrations, which are not only inconvenient but also affect overall metering accuracy. The actual pump rate prior to re-calibration can be off by as much as 5%, depending on the extent of pump tube wear and the time between re-calibrations.

In contrast, mass-flow metering has a number of advantages. The most important one lies in the high precision and high accuracy levels (RSD < 0.2%) that can be achieved with mass-flow metering without the need for pump re-calibrations. This advantage is further magnified when dealing with feeding intervals that stretch over many hours, days or even weeks. However, in order to achieve these long-term, superior precision and accuracy levels, the ChemTec requires hook-up of an electronic, top-loading balance.

In the Mass-Flow Mode, the ChemTec metering rate is constantly monitored and, if required, adjusted based upon feedback from an electronic balance or scale. The nutrient reservoir is located on the balance; the pump rate is calculated and maintained based upon the reservoir weight decrease during consecutive, 60-second intervals.

The resolution of the mass-flow rate is limited primarily by the resolution of the electronic balance. For high-performance electronic balances, e. g Mettler PGS, the resolution is +/- 0.005 grams. Thus, the lowest mass-flow rate achievable with high performance balances is 0.03 to 0.04 grams per minute. In order to implement such low mass-flow rates, a ChemTec equipped with an 8 RPM pump motor and a 1081 TANDEM pump head using #13 PharMed tubing is recommended.

The ChemTec responds to three, user-selectable alarm conditions. The Cumulative Weight (CW) or Cumulative Volume (CV) Alarm is triggered when the dispensed solution weight/volume exceeds a user-definable limit. For example, if the Cumulative Weight Alarm has been set at 2000 grams, the ChemTec will automatically stop pumping and alarm when 2000 grams of solution have been dispensed. Alternatively, the CW alarm can be selected to provide an auditory alarm while pumping continues.

The Pump Rate (PR) Alarm is triggered when the selected mass-flow rate cannot be maintained. This condition can occur when the solution reservoir is empty and air is pumped into the bioreactor. The ChemTec recognizes this condition since no further weight changes are detected. Alternatively, the ChemTec will also detect mass-flow rates that cannot be achieved with the selected pump motor / tubing combination. This condition can occur when the selected mass-flow rate requires a pump motor speed beyond 100%. The Pump Rate Alarm can be selected to either stop the pump or simply provide an auditory Beep while pumping continues. Before programming the ChemTec, check that the selected mass-flow rate can indeed be implemented with the installed pump motor/tubing combination.

Please Note: The Pump Rate Alarm only functions in the Mass Flow Programs. Volume Flow programs do not have the balance feedback available.

The End of Program (EP) Alarm stops the pump and provides an auditory Beep at the end of the user-defined program. At selected time intervals, all of the ChemTec pump parameters can be printed out or sent to a PC for data archiving, including cumulative weights, mass-flow rates, and alarms.

Once a ChemTec program has been implemented and is running, the access to ChemTec front panel can be disabled. Press the Star (*) key and select “Locked”, all front panel keys, except the Star (*) key, are now disabled. This feature prevents accidental pump status/parameter changes.

2.0 Linear, Volumetric Bioreactor Feed:

A SciLog customer provided the following data: A ChemTec was used to automate nutrient feed into a bioreactor. During the initial growth phase, a linear nutrient ramp was implemented that lasted four hours, followed by a very slow ramp during the remaining eleven hours:

Time, *hrs*	Rate, *ml/min*	Time, *hrs*	Rate, *ml/min*
0.0	35.60	7.5	96.96
0.5	43.21	8.0	97.02
1.0	50.66	8.5	97.10
1.5	57.83	9.0	97.16
2.0	66.04	9.5	97.23
2.5	73.65	10.0	97.29
3.0	81.26	10.5	97.37
3.5	88.87	11.0	97.43
4.0	96.48	11.5	97.50
4.5	96.55	12.0	97.56
5.0	96.62	12.5	97.65
5.5	96.69	13.0	97.65
6.0	96.75	13.5	97.65
6.5	96.83	14.0	97.65
7.0	96.89	14.5	97.65
		15.0	97.65

A ChemTec CP-120 with a TANDEM 1081 peristaltic pump head (160 RPM pump motor) was used for this feed application. PharMed pump tubing #16 was chosen which is capable of generating flow rates from 4.6 ml/min. to 120 ml/min.

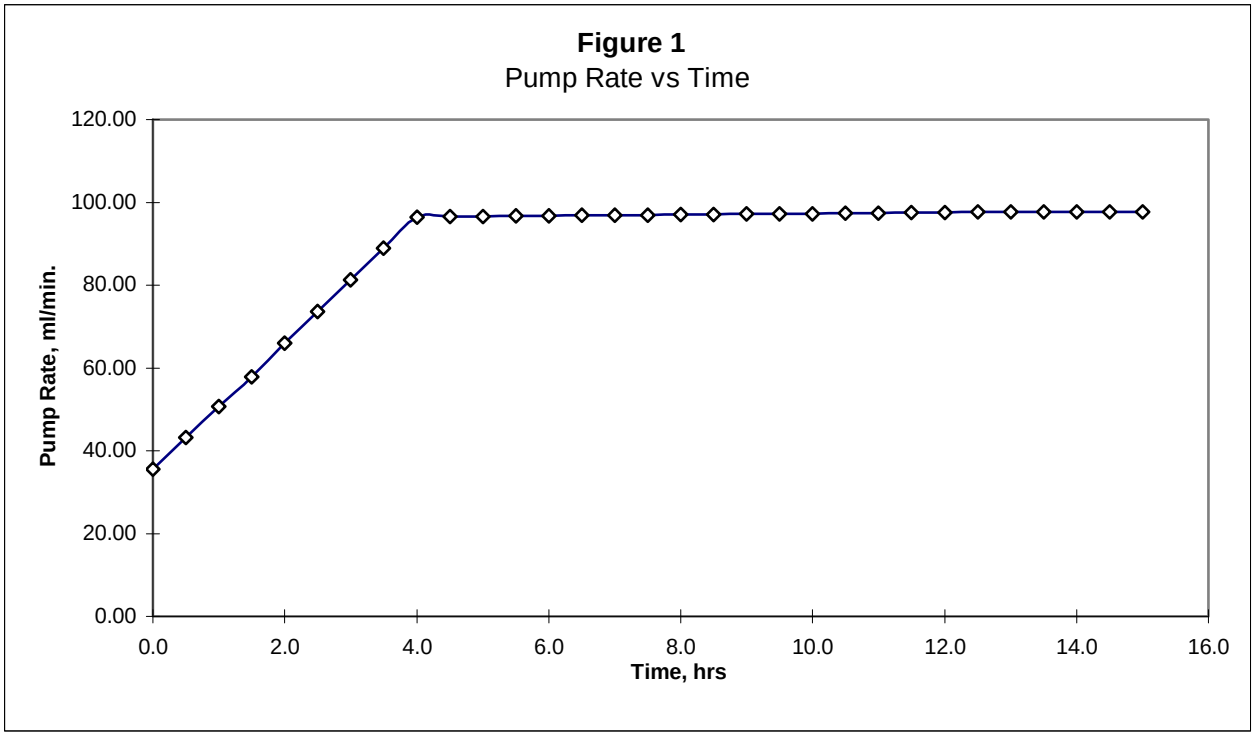
The following feed rate program was entered into **EDIT** of the **Volu Flow** mode:

000 START
001 CW
002 RUN
003 RATE = 35.60
004 INTRP = 96.48
005 TIME = 04:00
006 INTRP = 97.65
007 TIME = 11:00
008 STOP
009 COUNT = 1
010 END

When executing the above VOLU FLOW program, the ChemTec will generate an initial pump rate of 35.60 ml/min, which is ramped up to 96.48 ml/min. over a four-hour period. This initial ramp is followed by an almost constant pump rate, when actually; the pump rate of 96.48 ml/min. is increased to 97.65 ml/min. over an 11 hour period.

During the entire 15-hour operation of the ChemTec, no human intervention or supervision was required. The ChemTec performance data was printed out at 15-minute intervals.

Figure 1 shows the time profile for the nutrient addition.



3.0 Exponential Feed: Mass Flow, Example #1

A biotechnology company generated the following 75-hour, exponential feed. Utilizing a utility pump hooked up to a process control device, 150 data points were required to define the exponential feed strategy over this 75-hour period.

SciLog offered a simpler, alternative approach by generating an exponential feed based on six, linear segments, each segment being 12.5 hours long. This approach reduced the required number of data points from 150 to 7 without adversely affecting the feeding accuracy. The following data set, which was derived from the original 150 point data set, was used to define the six, linear feeding segments:

Time, *hrs*	**Mass Flow Rate**, *gr/min.*
0.0	0.37
12.5	0.50
25.0	0.69
37.5	0.94
50.0	1.28
62.5	1.75
75.0	2.39

A ChemTec CP-8 with a TANDEM 1081 peristaltic pump head (8 RPM pump motor) was used for this feed application. PharMed pump tubing #16 was chosen which is capable of generating pump rates from 0.4 ml/min. to 6.4 ml/min.

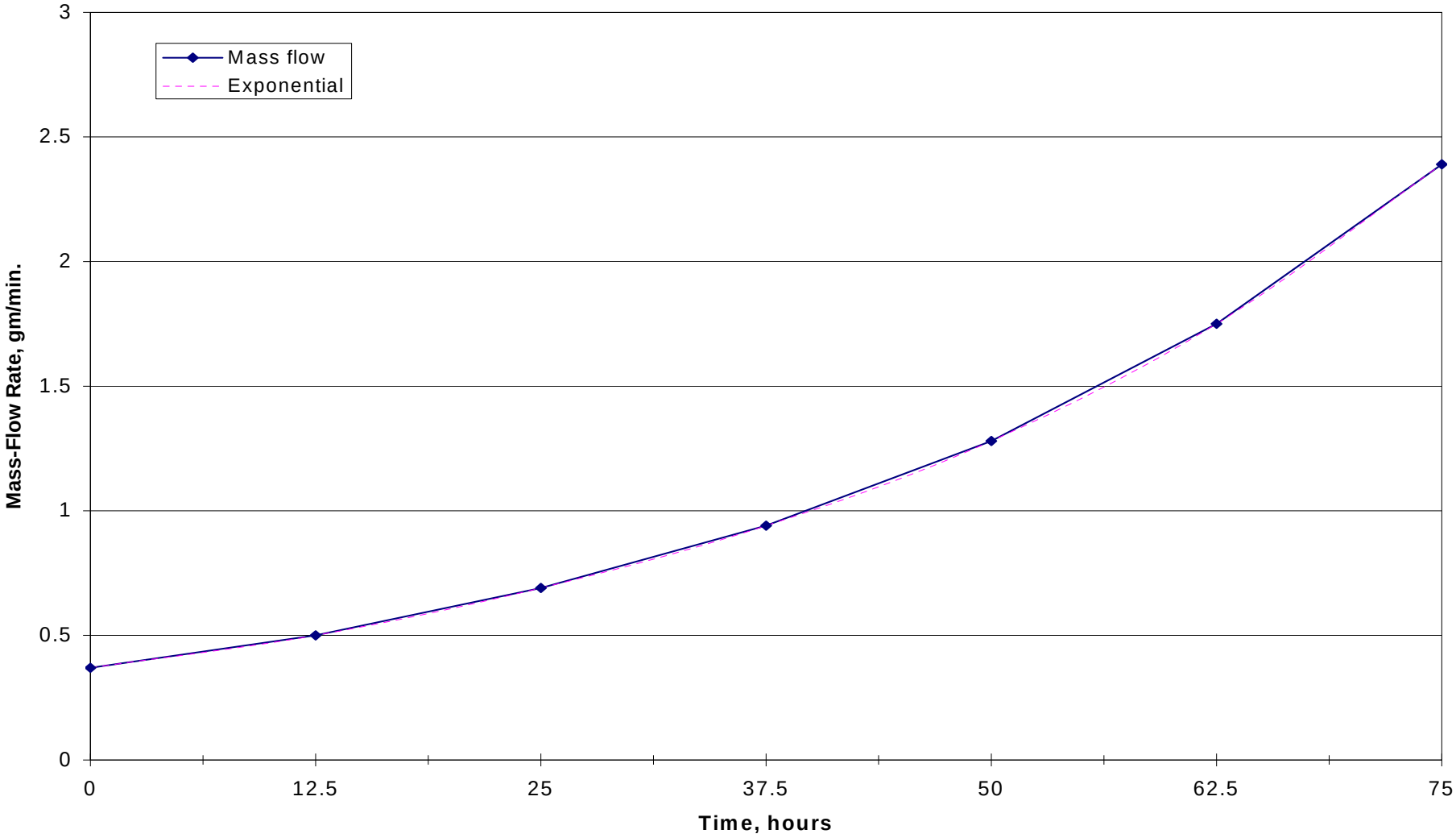
The following feed program was entered into **EDIT** of the **Mass Flow** mode:

000	START	010	INTRP = 1.28 g/m
001	CW	011	TIME = 12:30
002	RUN	012	INTRP = 1.75 g/m
003	RATE = 0.37 g/m	013	TIME = 12:30
004	INTRP = 0.50 g/m	014	INTRP = 2.39
005	TIME = 12:30	015	TIME = 12:30
006	INTRP = 0.69 g/m	016	STOP
007	TIME = 12:30	017	COUNT = 1
008	INTRP = 0.94 g/m	018	END
009	TIME = 12:30		

When executing the above program, the ChemTec will generate an initial pump rate of 0.37 g/m, which is ramped up to 0.50 g/m during the first 12.5-hour segment. As shown in **Figure 2**, the six linear segments provide an excellent fit. The largest deviation (error) from the original, exponential feed rate is found in the last segment, which starts at 62.5 hours and ends at 75.0 hours. If necessary, the error associated with the last segment can be substantially reduced by generating two segments each 6.25 hours long:

014	INTRP = 2.05 g/m	017	TIME = 6:15
015	TIME = 6:15	018	STOP
016	INTRP = 2.39	019	COUNT = 1

Figure 2
Mass Flow, Rate vs. Time



4.0 Exponential Feed: Mass Flow, Example #2

The following mass flow example represents an exponential feeding scheme with an initial time delay of 11 hours. Such a time delay is desirable and necessary when the bioreactor has an initial, large excess of nutrient. This high concentration of nutrient is converted into bio-mass during the initial growth phase. The nutrient level drops during this phase and must be subsequently replenished. At this point, the ChemTec starts metering fresh nutrient solution, first at a constant rate, then at an exponentially increasing mass flow rate:

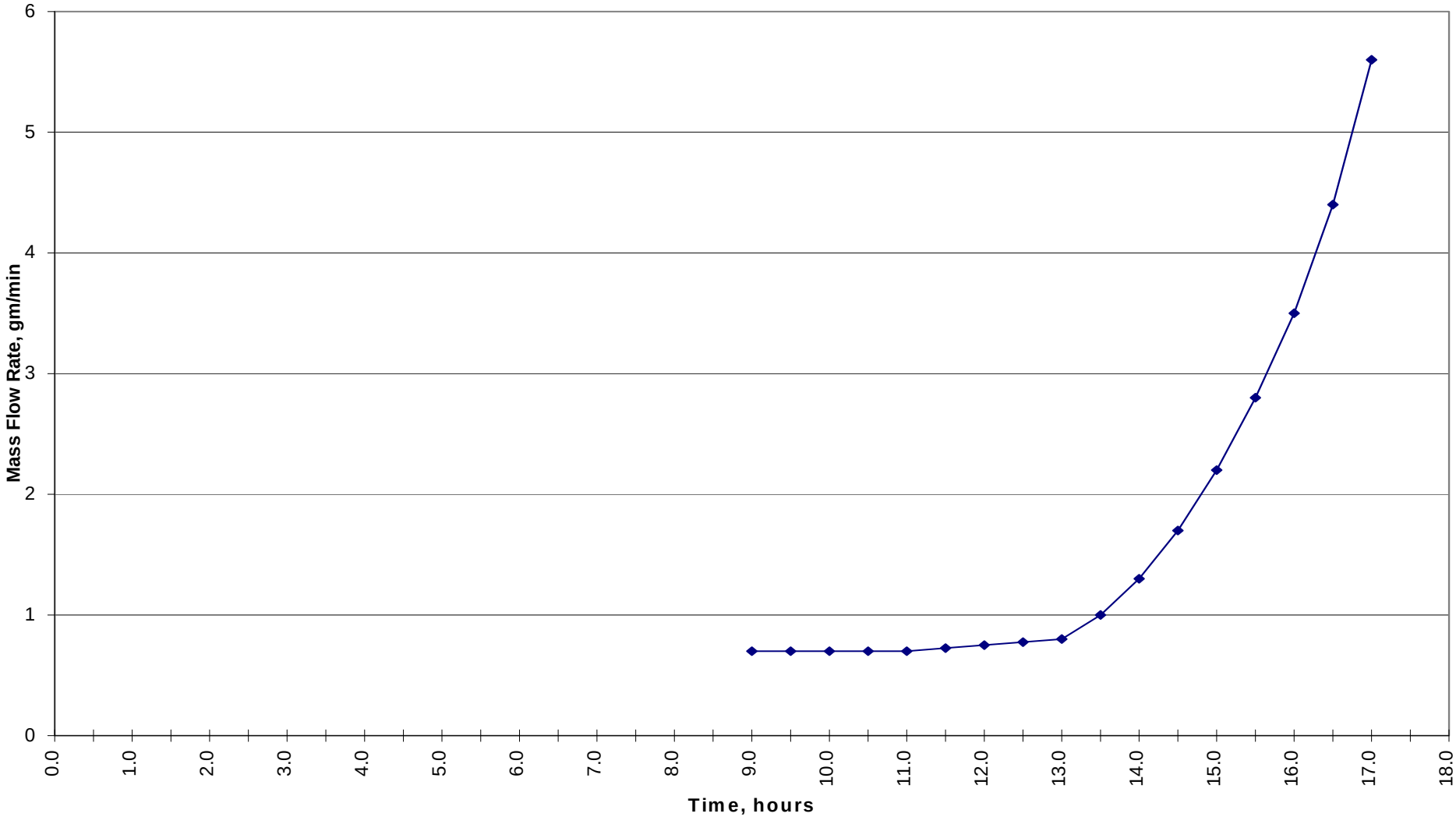
Time, *hours*	**Mass Flow Rate**, *g/min*
0.0	
0.7	
13.0	0.7
13.5	0.8
14.0	1.1
14.5	1.3
15.0	1.7
15.5	2.2
16.0	2.8
16.5	3.5
17.0	4.4
17.5	5.6

A ChemTec CP-8 with a TANDEM 1081 peristaltic pump head (8 RPM pump motor) was used for this feed application. PharMed pump tubing #16 was chosen which is capable of generating pump rates from 0.2 ml/min. to 6.0 ml/min. The following feed program was entered into **EDIT** of the **Mass Flow** mode:

001	START	014	INTRP = 1.70 g/m
002	STOP	015	TIME = 00:30
003	TIME = 11:00	016	INTRP = 2.20 g/m
004	RUN	017	TIME = 00:30
005	CW	018	INTRP = 2.80 g/m
006	RATE = 0.70 g/m	019	TIME = 00:30
007	TIME = 02:00	020	INTRP = 3.50 g/m
008	INTRP = 0.80 g/m	021	TIME = 00:30
009	TIME = 00:30	022	INTRP = 4.40 g/m
010	INTRP = 1.10 g/m	023	TIME = 00:30
011	TIME = 00:30	024	INTRP = 5.60 g/m
012	INTRP = 1.30 g/m	025	TIME = 00:30
013	TIME = 00:30	026	COUNT = 1

- The ChemTec will not be pumping for the first 11 hours although the program itself has been initiated and is running.
- After the initial waiting period of 11 hours, the ChemTec generates a constant mass flow rate of 0.70 g/m for 2 hours.
- Thereafter, the mass flow rate increases exponentially with time.
- The program terminates with a pump rate of 5.6 g/m 17.5 hours after initiation of the program.

Figure 3
Mass Flow Rate vs. Time



SciLog
Intelligent BioProcessing Systems

5.0 Preparative Chromatography: Step Gradients

The ChemTec is capable of automating preparative chromatography procedures: The ChemTec / valve combination provides user programmable access to wash solution and buffers but also allows redirection of column eluant and collection of LC fractions. Pump and valve actions are user programmable from the front panel. Access to buffer solutions is possible on a user-definable schedule. No external computer hook-up is required.

The ChemTec is equipped with the dual channel TANDEM 1081 peristaltic pump head and a 600RPM, high-torque motor. The motor is optically encoded and servo-controlled, thus providing a highly reproducible pump output. When used together with #16 PharMed pump tubing, the pump output ranges from 29 to 533 ml/min per pump channel.

NOTE: If greater pump output is required, the 600RPM ChemTec model will generate pump rate from 103 to 1515 ml/min. when used with #18 PharMed tubing. *However, carefully check the flow capacity and limitations of your particular rotary valve. Use a high-flow rotary valve model that can accommodate your selected pump rate range.*

For a simple, step gradient application, the ChemTec controls two (2) rotary valves. Valve "V" provides programmable access to **sample** solution, **Buffer "A"** or **Buffer "B"**. A second, six-port rotary Valve "W" connects the LC column or detector output either to **waste**, **sample return,** or to four different **fraction collection bottles 1-4**.

Enter the following program steps in the Volu-Flow Edit mode. NOTE: All of the selected time intervals were chosen arbitrarily; in a real application these time intervals may be significantly different. For your preparative chromatography application, select time parameters that meet your specific separation requirements:

Edit: *Program Steps* **Comments:**

1st Wash / Equilibration Cycle: Buffer "A" is pumped from buffer container (connected to "V1"), through the pump, LC column and detector to the waste container (connected to "W1")

000	START	
001	RUN	Pump turned ON
002	CW	Pump Direction: Clock-wise
003	V1	"V" Valve Position 1; Buffer "A"
004	W1	"W" Valve Position 1; Waste Bottle
005	RATE = 100ml/min.	Pump Rate = 100ml/min.
006	TIME = 00:05	Pumping Time = 5.0 min.

Sample Introduction Cycle**:** Sample solution is pumped for two (2) minutes through the LC column into a Sample Return Bottle. Note, the ChemTec pump rate is maintained at 100 ml/min. during this cycle. If a different pump rate is desired, e.g. RATE = 50 ml/min., then the new RATE statement must be inserted after step 006 and before step 009

007	V2	"V" Valve position 2; Sample Bottle
008	W2	"W" Valve position 2, Sample Return Bottle.
009	TIME = 02:00	Pumping Time = 2.0 min.

Edit: *Program Steps* **Comments:**

2nd Wash / Equilibration Cycle: Buffer "A" is pumped through the Prep LC column into the Sample Return Bottle. In this step, any sample not bound to the LC column will be washed off and pumped into the Sample Return Bottle. The "W" Valve Position 2 as well as the pump rate is maintained during this cycle.

010	V1	"V" Valve position 1, Buffer "A"
011	TIME = 05:00	Pumping Time = 5 min.

Step Gradient / Elution Cycle: The elution Buffer "B" is pumped through the LC column during this cycle. It may be desirable to discard the initial volume since it contains a high percentage of Buffer "A".

The first three program steps divert the initial volume to waste via "W1". Thereafter the eluant is collected via "W3" The ChemTec pump rate is maintained at 100 ml/min. during this cycle. If a different pump rate is desired, e.g. RATE = 80 ml/min., then the new RATE statement must be inserted before step 014. The elution time is defined by steps 014 and 016.

012	V3	"V" Valve position 3, Buffer "B", Elution Buffer
013	W1	"W" Valve position 1, Waste Bottle
014	TIME = 02:00	Pumping Time, 2minutes, NOTE: Select your time interval
015	W3	"W" Valve position 3, Collection Bottle #1
016	TIME = 10:00	Pumping (Elution) Time 10 minutes,
017	STOP	Pump stops
018	COUNT = 1	As the value is 1, the program is not repeated.
019	END	End of Program

Multiple Fraction Collection: Using all of the available ports of the "W" valve, up to four different fractions can be collected. A user-definable time interval is associated with each collected fraction. Use valve positions W3, W4, W5 & W6 for collecting the different fractions.

Again, the first three program statements, 012 – 014, are used to divert the initial elution volume to waste before collecting the fractions. All time parameters are user-definable and should be adjusted to meet the requirements of the process.

012	V3	"V" Valve position 3, Buffer "B", Elution Buffer
013	W1	"W" Valve position 1, Waste Bottle
014	TIME = 00:02	Pumping Time, 2minutes,
015	W3	"W" Valve position 3, Collection Bottle #1
016	TIME = 00:10	Pumping (Elution) Time 10 minutes,
017	W4	"W" Valve position 4, Collection Bottle #2
018	TIME = 00:10	Pumping (Elution) Time 10 minutes,
019	W5	"W" Valve position 5, Collection Bottle #3
020	TIME = 00:10	Pumping (Elution) Time 10 minutes,
021	W6	"W" Valve position 6, Collection Bottle #4
022	TIME = 00:10	Pumping (Elution) Time 10 minutes,
023	STOP	Pump stops
024	COUNT = 1	Program is executed only once.
025	END	End of Program

6.0 Preparative Chromatography: *Linear Gradients*

The ChemTec is capable of automating preparative, gradient chromatography procedures: To generate a linear chromatography gradient, two ChemTec pumps are electronically tied together thus operating synchronously as a system. In this arrangement, ChemTec #1 controls the "V" valve as well as the initiation of ChemTec #2. The "W" valve in turn is connected to and controlled by ChemTec #2.

For linear gradient applications, ChemTec #1 provides programmable access to **Sample** and **Buffer "B".** ChemTec #2 provides access to **Waste**, **Sample Return,** as well as to four **fraction collection bottles 1-4**. The ChemTec #2 also pumps **Buffer "A"** during the elution cycle.

During the gradient elution cycle, ChemTec #1 is programmed to ramp up its pump output (Buffer "B"), while ChemTec #2 is programmed to ramp down (Buffer "A") at the same rate. However, the combined output of ChemTec 1 & 2 remains constant throughout the gradient elution cycle.

Both ChemTec units are equipped with a TANDEM 1081 peristaltic pump head and a 600RPM, high-torque motor. The motor is optically encoded and servo-controlled, thus providing a highly reproducible pump-output. When used together with #16 PharMed pump tubing, the pump output ranges from 29 to 533 ml/min.

Enter the following program steps in the Volu-Flow Edit mode. NOTE: All of the selected time intervals were arbitrarily chosen; in a real application these time intervals may be significantly different. For your preparative chromatography application, select time parameters that meet your specific separation requirements:

ChemTec #1 Program Steps		ChemTec #2 Program Steps	
1st Wash / Equilibration Cycle			
000	START	000	START
001	RUN	001	STOP
002	CW	002	CCW
003	V1 (Buffer "B")	003	W1 (Waste)
004	Sw = 0000	004	TIME = 00:05
005	Sw = 1000 (Starts ChemTec #2)		
006	Sw = 0000		
007	RATE = 100ml/min.		
008	TIME = 00:05		
Sample Introduction Cycle:			
008	V2 (Sample Bottle)	005	W2 (Sample Return)
009	TIME = 00:02	006	TIME = 00:02
2nd Wash / Equilibration Cycle:			
010	V1 (Buffer "B")	007	W2 (Sample Return)
011	TIME = 00:05	008	TIME = 00:005
		009	W3 (Collection Bottle #1)

Continued on the next page.

ChemTec #1 Program Steps **ChemTec #2** Program Steps

Linear Gradient / Elution Cycle:

012	V1 (Buffer"B")	009	RUN
013	RATE = 70.0ml/min.	010	RATE = 30.0 ml/min.
014	INTRP = 30.0 ml/min	011	INTRP = 70.0 ml/min
015	TIME = 00:30	012	TIME = 00:30
016	STOP	013	STOP
017	COUNT = 1	014	COUNT = 1
018	END	015	END

Note: All of the selected time intervals were arbitrarily chosen; in a real application these time intervals may be significantly different. For your preparative chromatography application, select time parameters that meet your specific separation needs and requirements.

When you select your particular time parameters, it is essential that you enter the identical time parameters both in ChemTec #1 and ChemTec #2.

For example, the time parameter **015 TIME = 00:30** in ChemTec #1 is identical to the time parameter **012 TIME = 00:30** in ChemTec #2. To insure synchronous operation of ChemTec 1 & 2, the timing intervals in both programs must be the same.

Please Note: For ChemTec #1 Lines 004 thru 006 in the program above to function properly, Setup; Pump; TTL1 On/Off in ChemTec #1 must be set to NO. This allows the Sw Command to control TTL1.

Appendix “A”

Tandem™ Pump Head Installation and Maintenance

TANDEM™ Dual Channel Peristaltic Pump Head:

The TANDEM peristaltic pump head is specifically designed for use with the ChemTec system. The TANDEM pump heads (models 1082 & 1081) will provide you with rugged reliability as long as common sense maintenance and good quality pump tubing are used.

For continuous, heavy duty metering applications, the TANDEM 1082 (P/N: 080-1082) together with either #24 or #15 (thick-walled, 0.093" tube wall-thickness) Silicone or PharMed pump tubing is recommended.

The TANDEM pump head is driven by either an 8 RPM, 160 RPM, or 600 RPM high-torque motor. The ChemTec pump motor is optically encoded and servo-controlled, thus the TANDEM pump head will maintain a constant output over a wide range of metering conditions.

TANDEM Pump Head: Installation:

1. Identify the front and back of the TANDEM. Two 8-32 mounting cap screws, as well as the pump shaft tang extend from the back of the TANDEM pump head.
2. Facing the front of the TANDEM, open the pump head by moving the black loading lever 180° to the left. The upper and lower pump shoe will move in opposite directions, thereby exposing the inside of the upper and lower pump shoe channels.
3. With the TANDEM pump head completely opened, locate the mounting holes for the two 8-32 cap screws inside the lower pump channel.
4. On the front panel of the ChemTec, locate the mounting holes and the slotted pump head coupler.
5. Before fastening the TANDEM, align the two mounting screws and pump shaft tang of the TANDEM with the holes and slotted coupler of the ChemTec front panel mounting plate.
6. Make sure the TANDEM pump shaft tang is properly seated in the mating slot of the pump head coupler, before fastening the TANDEM to the front panel of the ChemTec.

TANDEM™ Peristaltic Pump Tubing / Rate Selection:

Select the appropriate pump head, pump motor and pump tubing combination from the table below.

MasterFlex Tubing	**13**	**14**	**16**	**25**	**17**	**18**	**15**	**24**	**35**
Tubing ID*: in	0.03	0.06	0.12	0.19	0.25	0.31	0.19	0.25	0.31
Tubing OD*: in	0.16	0.19	0.25	0.31	0.38	0.44	0.38	0.44	0.50
Tubing Wall*: in	0.06	0.06	0.06	0.06	0.06	0.06	0.09	0.09	0.09
Pump Rate Range*:	ml/min	ml/min	ml/min	ml/min	ml/min	ml/min	ml/min	ml/min	ml/min
CP-8 8RPM	0.03 - 0.45	0.10 -1.63	0.43 - 6.38	0.9 - 12.6	1.14 -18.3	1.7 - 24.3	0.5 - 13	0.65 - 20	N/R
CP-120 160RPM	0.5 - 10	1.7 - 35.2	6.3 - 129	12.5 - 283	18.5 - 405	24.7 - 554	9.6 - 240	14 - 412	N/R
CP-200 600RPM	2 - 34	8.6- 132	29 - 533	49 -974	70 - 1048	103 - 1515	59-993	85-1348	111 - 2258
* Nominal Values									
Pump Head Model:			**TANDEM 1081**				**TANDEM 1082**		

TANDEM™ Pump Tube Installation:

Open the TANDEM pump head by moving the black loading lever 180° to the left. If using the upper pump channel, slip the tubing into the upper channel; this is over the pump roller cage. If the lower pump channel is used, feed the tubing through the lower channel; this is under the pump roller cage.

Do NOT mount or dismount the pump tubing while the ChemTec is running.

NOTE: When using both upper and lower pump channels simultaneously, the same type of tubing should be used in each channel.

Lock the tubing in place by pushing the loading lever 180° to the right. The tube retainer spring will automatically place the correct tension on the pump tubing to prevent tube "walking".

With the TANDEM pump head closed, lightly pull the two ends of the tubing in opposite directions and away from the pump head. This pulling action insures that the pump tubing is taut and within the pump channel.

TANDEM™ Pump Tube Replacement:

The pump tubing section located in the TANDEM pump head should be advanced at regular time intervals if the ChemTec is heavily used. Only use high-quality SciLog or Masterflex™ pump tubing.

NOTE: When advancing pump tubing, the used pump tube section must be moved to the pump discharge side, i.e. dispensing side. The used pump tube section is weakened and tends to collapse when placed on the suction side of TANDEM pump head.

Appendix “B”
RH Series Pump Head Installation and Maintenance

RH Series Piston Pump Heads: General Information

The ChemTec FM-120, FM-200 and FM-520 systems use rotating, reciprocating piston pump heads of various sizes. In a reciprocating pump, the rotating piston moves back and forth inside the cylinder, sucking in fluid at the inlet while compressing and releasing fluid at the outlet. Flow rates for these pumps are varied by changing either the motor speed or the stroke length. The RH series of piston heads are excellent for precise fluid metering.

These ChemTec systems provide true positive displacement metering. They can handle pressures up to 100 psi. This style of pump head is appropriate for pumping of suspensions, as well as corrosive / non-aqueous liquids and slurries, emulsions, thin solvents, aqueous solutions and non-abrasive semi-solids. They are also capable of easily handling viscous fluids up to 2000 centipoises. You may pump fluids up to 10,000 cps by applying feed reservoir/line pressure to avoid cavitations.

Note: Piston pumps are not recommended for metering of biological fluids, or liquids containing biological cells or cellular components. High local shear is generated in the fluid along with strong mechanical agitation, which may destroy cells and fragment large molecular weight components such as DNA or large protein molecules.

Materials of Construction:

RH series pump heads have cylinder bodies and fittings made of either Kynar or Tefzel. The piston and cylinder liner are ceramic, except for the RH00 models, which use a stainless steel piston with a sintered carbon cylinder liner. An “LF” designation refers to a “Low Flow, low dead volume” pump connection, that utilizes ¼-28 HPLC nuts and ferrules with 1/8” or 1/16” tubing instead of compression fittings designed for 1/4” OD tubing.

Installation:

The following are directions for dismounting and installing a new pump head on a ChemTec. The ChemTec will come with the head already installed and ready to use.

1. Disconnect the power from the ChemTec.
2. Remove the two screws (6-32 x ½ RH) from underneath the ChemTec between and just behind the front feet.
3. Remove the four screws (6-32 x 3/8” FH) from the face plate at the front of the ChemTec.
4. Carefully remove the pump/motor subassembly from the ChemTec. Disconnect the motor cable from the pc board making note of how it was connected before completely removing it from the chassis.
5. Loosen the set screws on the head side of the coupler.
6. Using an offset screwdriver (It has a tip bent at right angles to the shaft), remove the head mounting screws (8-32 x ½”) from the rear of the face plate, allowing the head to be removed.
7. Reassemble the new head by reversing this process.
8. Test the ChemTec with the new head installed after making fluid connections to both ports of the pump head. Do not let the pump head run dry without fluid for prolonged periods.

Stroke Volume Adjustment:

The knurled Adjustment Ring on the RH series piston head controls the stroke length and thus the output per motor revolution. This Adjustment Ring is factory set to “200”.

By turning the ring clockwise, the stroke length is reduced, and consequently by turning it counterclockwise, the stroke length is increased.

Please do not turn the head clockwise further than a setting of “50” or counterclockwise further than “450”.

Turning the Adjustment Ring past the 450 mark will eventually result in the ring falling off the pump head.

Chemical Compatibility:

The RH series of pump heads are well known for their robustness and overall chemical compatibility with many process fluids. The materials used in manufacturing are inert to most chemicals, however the following exceptions must be observed:

- In the model number of the head, the “T” in CTC refers to Tefzel, and the “K” in CKC refers to Kynar.
- For applications involving fluids above 90°F do not use heads with Tefzel cylinder body material. Please use either Kynar, or consult with SciLog about the availability of stainless steel heads for your application.
- While Kynar has good chemical resistance to most fluids, Kynar heads must not be used with Acetone, Ketones, or Esters.
- When pumping Acetone, Toluene, MethylEthylKetone, Methanol, Ethanol, Hexyl Alcohol, Isobutyl Alcohol, or Isopropyl Alcohol, pump heads with Tefzel cylinder bodies must be used.

Viscosity Effects:

When pumping high viscosity liquids, you should always use large bore tubing (1/4” OD), slow pump rates, and large stroke volumes. Set the knurled Adjustment Ring to the “400-450” range.

The ChemTec FM-200 together with either a RH0 or RH1 can handle fluid viscosities up to 2000 cps. Viscosities of up to 10,000 cps can be pumped when the fluid reservoir and /or feed line connected to the pump inlet port are pressurized to avoid cavitations.

H431-02

INSTRUCTIONS FOR ALL "H" MODEL PUMPS

MODELS RH, RHB, RHSY, RHV, PIP

LAB PUMP JR.

ISO 9002

CONGRATULATIONS! YOU ARE WORKING WITH ONE OF THE FINEST METERING PUMPS IN THE WORLD - THE FMI LAB PUMP JR., MODEL RH - A RUGGED LITTLE PACKAGE OF EXCEPTIONAL PUMP PERFORMANCE! ITS FLUID PATH IS MADE OF CERAMIC AND FLUOROCARBON TO GIVE IT OUTSTANDING RESISTANCE TO LABORATORY CHEMICALS; ITS INTERNAL DIMENSIONS ARE MEASURED IN MICROINCHES TO PRODUCE MICROLITER RESULTS. USE IT WISELY AND IT WILL GIVE MANY YEARS OF TROUBLE FREE SERVICE.

SAFETY INSTRUCTIONS

Before using any Fluid Metering, Inc. product read the following safety instructions as well as specific product specifications and operating instructions.

Warning! Fire, electrical shock or explosion may occur if used near combustibles, explosive atmosphere, corrosive air, wet environment or submerged in fluid.

- Turn off the electrical power before checking pump for any problems.
- Connect motor, speed controllers, or any other electrical devices based on Fluid Metering Inc. specifications. Any unauthorized work performed on the product by the purchaser or by third parties can impair product functionality and thereby relieves Fluid Metering, Inc. of all warranty claims or liability for any misuse that will cause damage to product and /or injury to the individual.
- Power cables and leads should not be bent, pulled or inserted by excessive force. Otherwise there is a threat of electrical shock or fire.
- Replace any in-line fuses only with fuse rating as specified by Fluid Metering, Inc.
- When pump/drive is under operation, never point discharge tubing into face or touch any rotating components of pump.
- In a power down thermal overload cut-in condition, unplug or turn off power to pump. Always allow a cool down period before restarting: otherwise, injury or damage may occur.
- For 30 seconds after power is removed from pump/drive: do not touch any output terminals. Electrical shock may occur because of residual voltage.

Caution! Fire, electrical shock, injury and damage may occur if not used in accordance with Fluid Metering, Inc. specifications and operation instructions.

- Do not put wet fingers into power outlet of unit.
- Do not operate with wet hands
- Do not operate drive assemblies that require a hard mount (to be bolted down) unless they are mounted per Fluid Metering, Inc. specifications, if not injury may occur and/or damage to unit.
- Do not touch any rotating pump or motor components: injury may occur.
- Do not run pump dry, unless designed for that service.
- Running dry is harmful to the pump, and will cause excessive heating due to internal friction.
- Check pump rotation and inlet/outlet pump port orientation before connecting power to pump. If not injury may occur.
- When pulling out cords from outlets do not pull cord, grasp plug to prevent plug damage or electrical shock.
- Fluid Metering, Inc. Drive Motors become **HOT** and can cause a burn. **DO NOT TOUCH!**

INSTALLATION & OPERATING TIPS

1. CLEAN FLUIDS. Abrasives in the pumped fluid may damage cylinder and piston surfaces and should therefore be avoided.

2. COMPATIBLE FLUIDS. Pump only fluids compatible with materials of construction of your pump.

3. WET OPERATION. The pumped fluid provides surface cooling and lubrication to the piston and cylinder of your FMI PUMP. Therefore avoid dry operation (except pumps specifically designated "gas pump").

4. PRESSURE. Do not operate pump against pressures in excess of design specification. Drive pin on piston may bend or break under overload and other irreparable damage may be suffered. Avoid dead heading. **Check your fluid circuit before applying power to the pump!**

5. CLEANING YOUR PUMP. Routine flushing with solvent before shut-down will suffice for most applications. Set pump for maximum stroke and operate until solvent appears clear at discharge port.

CAUTION! Ceramic piston/cylinder sets are sensitive to neglect and may "freeze if allowed to dry out without adequate cleansing. Fill a loop of flexible tubing with fluid that will thin or neutralize the last fluid pumped. Then connect one end of the tube to the pump suction port, the other to the discharge port. With this loop positioned above the pump head, the ceramic surfaces and seal areas stay moist and mobile for extended idle periods. If, however, a piston does freeze in the cylinder, DO NOT TRY TO FORCE IT FREE! Be gentle. Try to remove the pump head (refer to para. 20) from the base assembly so the whole pump head can be soaked in a suitable solvent. If the head is not conveniently removable, the tube loop discussed in the prior paragraph may permit solvent to dissolve the "frozen" residue in reasonable time. If all else fails, pack it all up and ship it back to the factory with a note telling us what you think might be left inside - sometimes we're lucky. New pump heads are expensive and realigning pump drive components is tedious work, so avoid freeze-ups or, if you feel you must have them, try to correct them gently!

6. ADAPTING RH PUMP HEADS TO STANDARD Q PUMP DRIVE MODULES. (refer to figs. 1,7c) The RH/Q Kit adapts the RH pump heads to standard Q Pump Drive Modules. Assemble as follows:

a) Assemble Kit parts to RH pump head as shown (fig. 1) with "shoe" of part H481-1 down. Slip COUPLING H482 fully onto pump shaft, with its slot away from pump head and SET SCREW 110288-4 contacting the flat on the pump shaft.

b) Insert DRIVE PIN 110301 of Kit into SPHERICAL BEARING 110292 as shown.

c) Orientate coupling slot to accept P/N 110301. On Q drives the shoe is slipped between the base Q402 and Q616 assembly.

FLUID METERING, INC.
5 AERIAL WAY, SUITE 500, SYOSSET, NY 11791
(800) 223-3388 • (516) 922-6050 • FAX (516) 624-8261 • http://www.fmipump.com

ISO 9002

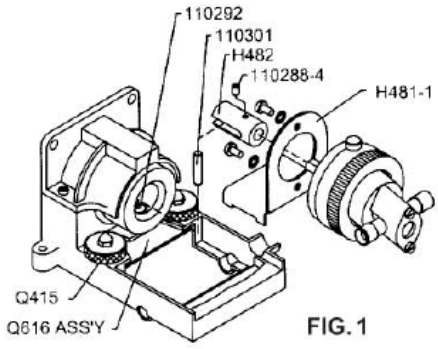


FIG. 1

d) Tighten thumb NUTS and operate motor. If noisy, alter position of BRACKET under RETAINER PLATE slightly while operating until minimal noise position is found. Retighten thumb NUTS.

7. MOUNTING RH PUMP. For maximum pump performance, mount RH pump with motor at 12 O'Clock and pump head at 6 O'Clock position. This orientation will allow air bubbles that enter the pumping chamber to directly exit through buoyant assist. Discharge lines should be inclined upward from pump head.

7.1. PANEL MOUNTING OF RH PUMP HEADS. Two threaded holes (#8-32) are provided on the back side of each RH pump head for panel mounting purposes. A bearing adjustment access hole is also required. Each panel mount layout should, therefore, provide the three holes as shown in fig. 2. below.
It will be noted that the center line of the pump ports is displaced 90° from the center line of the pump mounting holes. Thus, a vertical hole pattern in the mounting panel will result in horizontal port alignment of the pump; a horizontal hole pattern will give vertical port alignment.

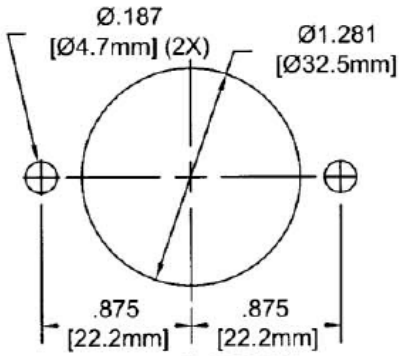


FIG. 2

RHSY

8. RHSY Series pumps are powered by belt-coupled synchronous motors (refer to figs. 4 & 7c). To service this type of pump, **un-plug power cord**, loosen THUMB SCREW 110437 on rear of CASE ASSEMBLY HSY-109 from COVER ASSEMBLY HSY-113. It will then be noted that a machine SCREW 110230-6 and a STAND-OFF 110439 serve to lock the RH pump head assembly and the SY motor assembly to the COVER ASSEMBLY HSY-113. Removal of the machine screw and stand-off permits removal of pump head and/or motor bracket assembly. Loosening the two machine SCREWS 110132-3 holding the MOTOR ASSEMBLY HSY-110- permits adjustment of the drive belt tension (relocates motor position).

Pulley grooves on motor and pump must be in alignment as shown in fig. 4. SET SCREWS 110288-2 in parts HSY-102 and HSY-105 may be loosened as necessary to achieve such alignment. **Tighten screws** after any service adjustment and **replace CASE ASSEMBLY HSY-109** before plugging electric cord into outlet.

Belt tension should be adjusted to taut condition (no arc in belt between pulleys) but should not excessively stretch the belt. Pump stroke rate is controlled by the groove position in which the belt has been placed. Thus in fig. 4, with belt in central position as shown, the pump operates at 300 strokes per minute; with belt on the small-**motor**-pulley and large-**pump**-pulley, (fig. 4) it operates at 150 strokes per minute and with the belt on the large-motor-pulley/small-pump-pulley the pump operates at 600 strokes per minute.

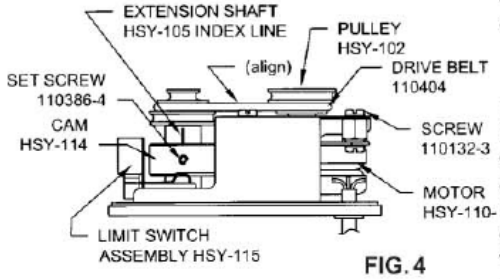


FIG. 4

"PiP" micro π-petter®

9. The FMI micro π-petter® "PiP" has three switches to control its functions: 1) A PENDANT (squeeze button) switch at the end of a 6' long remote operating cord. This switch starts and stops each operating cycle. It is sealed and can be actuated by hand, foot or other remote pressure means. 2) A "MODE" switch face-mounted on the PiP. In the down or SINGLES position this switch permits only one dispense or aspirate pulse per squeeze of the PENDANT and the up or REPEAT position permits the PiP to operate continuously as a pump, when pendant is squeezed operation is temporarily disabled. A center OFF position on this switch provides system-off facility. 3) A DIRECTION switch controls and indicates the direction of fluid flow through the PiP pump head. Pushing the direction switch to the FWD or up position will cause flow in that direction. Push switch down to the REV position to reverse flow direction.

RH PUMP HEAD CALIBRATION

10. HOOK-UP. The pump ports of the FMI RH Pump Head are designed to accept 1/4" outside diameter (O.D.) tubing and/or tubing adapters. (see fig. 7a) The lower port is normally for suction, the upper port for discharge. Suction tubing should be soft and flexible with largest possible inside diameter, shortest practical length. Discharge tube may have smaller inside diameter than suction tube and may incorporate dispense tip or other partial flow restrictors.

11. BUBBLE -CLEARING. After tubing has been securely installed in each of the pump head fittings and the suction line is in the supply fluid, plug electric cord into outlet and operate pump in forward mode until apparent bubbles are cleared from fluid lines. Then, while pump is still operating, pinch-close the suction line for 10 to 15 seconds to cavitate residual bubbles from pump head. Continue to operate until all bubbles are cleared from discharge tube.

12. PUMP STROKE ADJUSTMENT. The knurled ADJUSTMENT NUT on the pump head controls stroke to stroke piston displacement. Turning it clockwise to zero stops displacement. Turning the ADJUSTMENT NUT counterclockwise four and one half turns from zero (450 on scale) (fig. 5) causes maximum pump reciprocation, e.g., 50 µl per stroke for the H-0 or 100 µl for the H-1 unit. Thus each 1-1/8 turn (112.5 on scale) of the ADJUSTMENT NUT represents 25 of maximum (12.5 µl for H-0 and 25 µl for H-1) and each graduation on the ring represents an **adjustment** of 1/450th of maximum (0.111 µl for H-0, 0.222 µl for H-1).

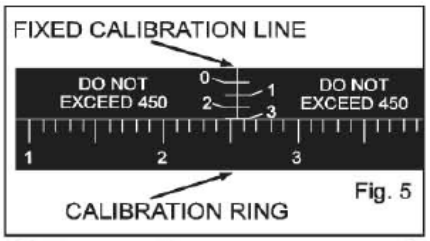


Fig. 5

13. PiP RECALIBRATION. Turn knurled ADJUSTMENT NUT 2-1/4 turns CCW (225 on scale) from zero displacement position. Clear bubbles from line and pump 20 shots into a calibrated receiver (pipette, burette, graduate). Divide the measured volume by 20 to find the per shot volume, which should be 25 µl for the H-0 or 50 µl for the H-1. If an error exists repeat the foregoing. If error is confirmed, adjust for error difference (CW for decrease, CCW for increase) using CALIBRATION RING graduations to measure distance to new setting. Repeat test and correction procedure until correct result is achieved. Then, loosen THUMB SCREW on CALIBRATION RING and rotate ring to obtain a reading of 225 when the CALIBRATION RING is aligned with the fixed calibration line on the left side of the pump. Retighten THUMB SCREW. Your pump is now recalibrated for stroke adjustment as per paragraph 12.

14. Your micro π-petter® "PiP" is similar in design to a standard FMI RHSY metering pump unit. Please review paragraphs 1 through 8 for details regarding the RH pump head and the RHSY drive system.

15. CAM ADJUSTMENT. Your micro π-petter® PENDANT SWITCH relates directly to a CAM HSY-114 actuated LIMIT SWITCH ASSEMBLY HSY-115 which is timed to the RH piston suction position; to adjust this CAM, **unplug power cord**, loosen THUMB SCREW on rear of CASE ASSEMBLY HSY-109-1 and remove CASE ASSEMBLY. The CAM timing and height are adjusted by one SET SCREW 110386-4 (see fig. 4). Align SET SCREW in CAM to index line on EXTENSION SHAFT HSY-105. Lower CAM until recessed surface of CAM contacts LIMIT SWITCH ASSEMBLY HSY-115. Tighten set screw. Check for 2 SWITCH "clicks" per revolution. **REPLACE CASE ASSEMBLY** before plugging electric cord into outlet.

16. NOISE AT HIGH PUMP RATES. A metallic hammering noise during operation of your pump (particularly high speed units such as RHB and RHV) when pumping liquids indicates presence of gas bubbles in the pumping chamber which are reducing pumping capacity and may be damaging cylinder walls. Such bubbles may be traced to 1) a poor seal at the suction fitting, 2) fluid vaporization (cavitation) or, 3) degassing of the fluid.

a) To eliminate vaporization and degassing noise, reduce suction load. This may be accomplished by: 1) Increase in suction line inside diameter; 2) reduction of suction supply height; 3) pressurization of suction supply container; 4) locating pump below supply source to permit gravity flow aid; 5) reduce viscosity of fluid by heating or thinning; 6) reduce flow rate by adjusting pump to lower setting on flow scale; 7) install FMI PD-HF PULSE SUPPRESSORS in suction and discharge lines. We hear of good results in noise abatement and pump life extension from folks who put pulse suppression hardware in their plumbing circuits adjacent to the pump suction and discharge ports - particularly with high speed pumps, RHB and RHV, that are plumbed with rigid tubing. Theory holds that if part of a generated pulse is resiliently stored, the part not stored is smaller and thus easier to get in motion; the stored part of the pulse dissipating behind the part that is in motion sustains motion, causing an undulating flow to be transmitted rather than a series of pulses. Results; less noise, less energy used and less agitation of the pumped fluid. So for pulse noise and vibration problems, put a little resilience in your circuit. There are a number of easy ways to do it.

b) The simplest method is to use resilient tubing between the pump and the fluid circuit. Experiment a bit with standard elastomers - viton, hypalon, gum rubber, soft vinyl or other. Use only unreinforced tubing (reinforcement takes away the resilience). **Always shield this type of arrangement** so that a possible tube rupture will not endanger people or equipment.

c) Another popular pulse suppression arrangement involves a gas bubble trap. A bubble in such a vertical trap will suppress pulse shock and noise temporarily. However, since gas and a liquid in contact under agitated conditions seldom stabilize, the trapped gas may be absorbed into the passing liquid and disappear leaving no pulse suppression or the fluid may contribute to the gas quantity, overload the trap and cause random pumping errors as occasional bubbles enter the flow stream. This can be overcome by fitting a soft slug of closed-cell-plastic foam or a soft pillow of thin-wall plastic tubing (ends sealed) into the vertical dead end extension of the fluid line. The gas trapped in the foam or pillow will provide the required resilience but will not be absorbed by the flow stream.

d) Since each fluid and circuit exhibits a differing characteristic, a bit of experimentation may be necessary. The results are usually worth the effort.

17. FOR BEST LOW FLOW PUMPING RESULTS: Use a pump having maximum flow rating as near to the desired flow rate as possible and keep suction and discharge pressures essentially constant (see para 19). You may obtain fine results with the new FMI RH-LF Pump Head fitted with Q661 a Small Bore Tubing Kit. And, to assure continuous good results, beware of bubbles! (see para 18)

18. LOW FLOW BUBBLE PROBLEMS. A common cause of trouble in metering pump applications requiring low flow rates - a few milliliters per minute or less - is the seemingly inevitable gas bubble trapped in the pumping head of the metering pump. It expands on the suction stroke and contracts on the discharge stroke, allowing little, if any, liquid to pass through the pump. Such bubbles, though often attributed to leaks in pump seals, can usually be traced to gases released by the pumped fluid in response to pumping agitation or pressure/temperature changes. When so identified, this potential source of metering pump error can be effectively controlled in most fluid circuits.

The familiar bubbles that form on the inside walls of a tumbler of tap water after it stands for a period of time at room temperature demonstrate the typical liquid degassing that results from pressure reduction (water line pressure to atmospheric) and/or temperature elevation (from ground ambient to air ambient). In this case, the bubbles contain air, hydrogen, carbon dioxide or other gaseous materials carried in the water, only small quantities of vaporized water are present. Some liquids respond to agitation and/or pressure/temperature changes by chemically separating into liquid and gas fractions; others simply vaporize, physically changing from liquid to gaseous form. Examples of liquids releasing gas or changing from liquid to gaseous form in response to agitation and temperature/pressure changes are numerous in the modern technical environment and many techniques have been devised to compensate for or correct their presence.

The most common practices for bubble control employ:

a) pressure on the suction side of the pump circuit to encourage gas retention in the liquid or,

b) employ natural buoyancy of the bubbles to carry them away from or through the pump head.

To apply pressure on the suction side of the pump, locate the pump physically below the supply vessel. Each two feet of elevation difference represents pressure of approximately one pound per square inch (psi). Bubbles that do occur will return to the supply vessel by buoyant lift. This is called a positive suction or flooded suction arrangement.

If it is necessary to draw liquid up from the supply vessel to the pump head, negative suction pressure must be contemplated - again, approximately 1 psi per two feet of lift. Most liquids will release some gas when held at negative pressure and since the volume of gas released is generally proportionate to the volume of liquid subjected to the negative pressure, suction line diameter should be kept small for small flows (except heavy, viscous or tacky liquids which require large flow area for mobility). A vertical dead-end extension of the suction line can be provided above the pump suction port to trap line-generated bubbles before they enter the pump. This extension should be liquid filled at the start of a pumping period.

Hanging the pump vertically with motor at 12 noon and pump head at 6 pm will allow bubbles that enter the pump head to pass directly through with buoyant assist. Discharge lines should be inclined upward from pump head and bubble traps should be purged as often as necessary to assure liquid flow continuity.

19. SYSTEM PRECISION FACTORS. Several interrelated factors are involved in the exceptional operating precision possible in systems using FMI LAB PUMPS. Of primary concern are the following:

a) FMI LAB PUMP DISPLACEMENT precision is based on a simplified positive stroke mechanism which has no secondary linkages to produce stroke to stroke mechanical errors and has no gravity actuated or spring loaded valves to introduce random valve seating errors. The single mechanical linkage components between the LAB PUMP piston and its drive elements is a precision spherical bearing which transforms circular drive motion into elliptical thrust motion (reciprocation). The total mechanical clearance of this linkage is less than 0.1 of the maximum pump stroke length or, approximately 0.0003". Thus it may be said that LAB PUMP **displacement precision** (stroke to stroke) is in the order of the mechanical linkage clearance; that is to say, stroke to stroke displacement is reproducible to less than 0.5 within the rated capacity of a given pump model.

b) FMI LAB PUMP VALVING is performed by a slot in the piston which is mechanically aligned with one cylinder port during the suction portion of each stroke and with the other cylinder port during the discharge portion of each stroke. The slot alignment is controlled by the single drive bearing discussed in the preceding sentences. The valve action is therefore mechanically precise, and free of random closure variations.

c) FLUID SLIP, a term commonly used to describe the migration of fluid around the internal moving parts of gear, lobe and vane pumps, is the volumetric difference between physical component displacement and fluid through-put of a pump system. In the FMI LAB PUMP, slip loss refers to the fluid which passes through the clearance space (approx. .0002") between the piston and the cylinder wall. Since this clearance represents a restrictive passage of essentially constant dimension, it will be readily seen that the slip rate is determined by viscosity, pressure and time: e.g. assuming constant fluid viscosity and pressure, slip will be a smaller factor in a high repetition rate pump (short time per stroke) than in a low repetition rate pump. As viscosity increases and pressure decreases, time (or repetition rate) becomes less a significant contributor to slip loss.

d) STROKE REPETITION RATE is directly related to drive motor speed which in turn is influenced by work load and electrical supply voltage, i.e. motor speed decreases when work load increases and when electrical supply voltage (115 Volts AC) decreases. This motor speed variation may amount to as much as 15 for work load variations between zero discharge pressure and maximum rated discharge pressure. A 10 voltage drop may result in as much as 20 motor speed reduction when the pump is operating against a significant head pressure.

e) THE FLOW STABILITY (precision) of an FMI LAB PUMP is therefore principally related to consistency in fluid slip rate and stroke repetition rate and these functions in turn are related to external system load factors such as viscosity, differential pressure and electric line voltage; i.e., when load factors remain essentially constant, slip rate and repetition rate remain essentially constant; when viscosity increases, fluid slip rate and stroke repetition rate both decrease; when differential pressure increases fluid slip rate increases and stroke repetition rate decreases.

In short, FMI LAB PUMP PRECISION is influenced by fluctuations of fluid differential pressures, fluid viscosity and electric line voltage. When these factors are controlled predictably reproducible pumping precision better than 0.5 may be expected.

MAINTENANCE & REPAIR INSTRUCTIONS

20. REMOVING PISTON/CYLINDER GROUP ASSEMBLY. (refer, Fig 8.) remove two 110655-20 screws and while holding cylinder ports in place, slip part H435 off of CYLINDER ASSEMBLY H422. Tilt the assemly as shown in **figure 8.** This will permit removal of PISTON DRIVE PIN 110366 from SPHERICAL BEARING H477 **without fully withdrawing piston from liner.**

21. SERVICING OF PISTON/CYLINDER GROUP ASSEMBLY. If teardown for detail cleaning or seal replacement is required, remove parts with care to avoid damage to piston, cylinder and seals. For piston/cylinder sets with scavenger slots. Carefully remove all solid matter that may have collected in the scavenger slot - the groove inside the cylinder liner that extends from the left hand port to the seal reservoir. This tiny groove serves the dual purposes of minimizing seal wear and seal weepage by maintaining near atmospheric pressure on the inside seal surfaces. KEEP IT CLEAN! Wipe all parts with lintless oil-saturated cloth. The H408 SEALS that keep your LAB PUMP piston dry are not "just ordinary plastic discs." They are precisely cut and formed from sheets of chemically inert fluorocarbon, specifically formulated for resistance to wear, abrasion, heat and chemical attack.

Each H408 SEAL possesses an exceptional mechanical memory which allows it to maintain a relatively constant wiping pressure on the piston, compensating for seal wear as it occurs. Properly maintained in cleaned condition, the original SEALS on an FMI LAB PUMP may be expected to last the life of the pump. If they are removed for any reason, they should be carefully cleansed of all foreign particles prior to reassembly. Seal seats must also be free of particles.

When H408 SEALS are replaced, the following procedure should be followed: (please see fig. 7a)

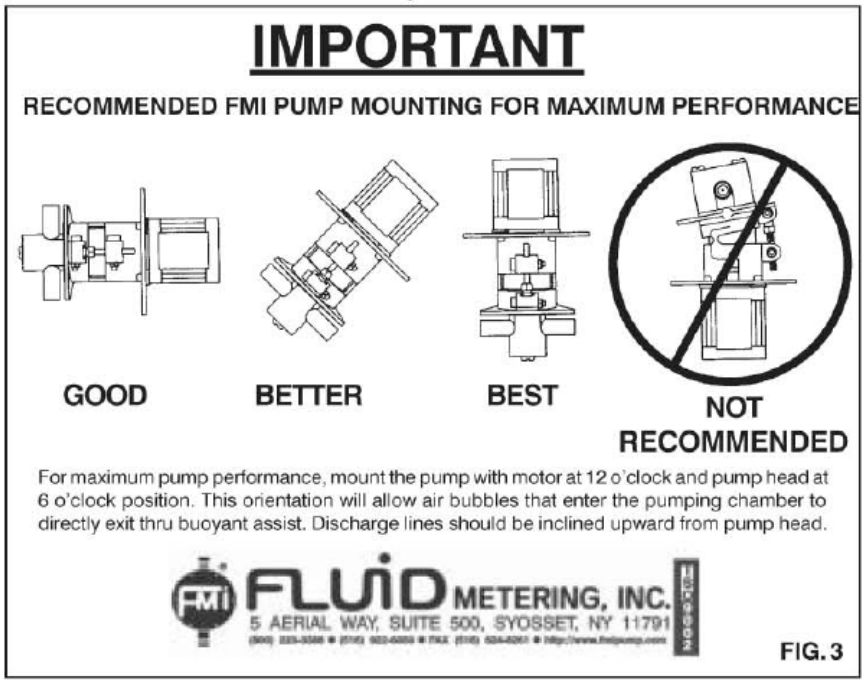


FIG. 3

a) Place GLAND NUT H406 and GLAND WASHER H409 on PISTON ASSEMBLY H423.
b) First "form" lip of LIP SEAL around piston by gently placing a LIP SEAL H408 on piston, **lip side last.** Carefully rotate the seal on the piston to avoid damage to the lip while passing over the flat to the piston neck. *Then remove seal and reverse lip direction.*
c) Gently place one "formed LIP SEAL H408 on piston, **lip side first,** carefully rotating the seal on the piston until it is past the flat and on the piston neck.
d) Gently place two LIP SEALS H408 on piston, **lip side last**. Carefully rotate the seals on the piston to avoid damage to the lip while passing over the flat to the piston neck.
e) Insert piston into CYLINDER ASS'Y H422 and tighten GLAND NUT H406.
f) Rotate piston by hand after reassembly to assure free movement in cylinders and seals.

22. PISTON/CYLINDER GROUP ASSEMBLY REPLACEMENT. (refer, figs. 8 & 9) Install "O" RING 110036 over GLAND NUT H406. Note in fig. 8 that PISTON DRIVE PIN 110366 must be guided into SPHERICAL BEARING H477-1 while the piston and cylinder remain assembled. This for the purpose of avoiding assembly damage to the seals. When PIN is in bearing, seat GLAND NUT with "O" RING in SUPPORT H433 as shown in fig. 9. **OPERATE PUMP MANUALLY FOR SEVERAL STROKES BEFORE APPLYING POWER.**

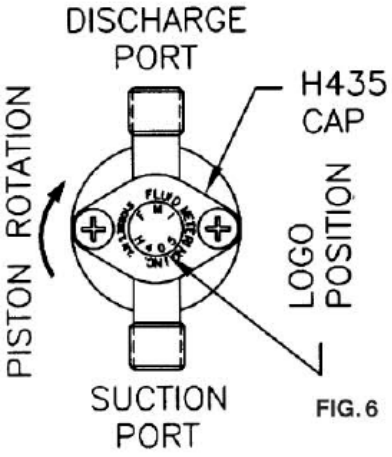


FIG. 6

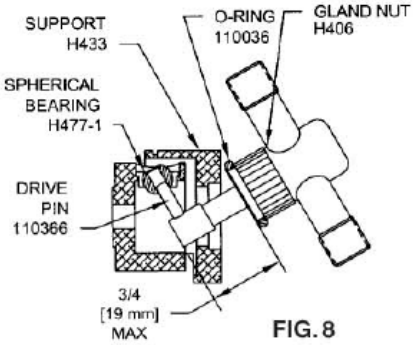


FIG. 8

NOTE THAT PISTON IS VISIBLE IMMEDIATELY BEHIND "LOGO" DURING AT LEAST PART OF EACH REVOLUTION OF PUMP SHAFT - WITHOUT ACTUALLY CONTACTING BACK OF "LOGO"

23. ADJUSTING PISTON/CYLINDER RELATIONSHIP. (refer, figs. 7a, b) If piston is not visible behind "LOGO" or if it contacts "LOGO" during operation, H485 BEARING ASSEMBLY should be adjusted. This situation may occur when PISTON ASSEMBLY H423 has been replaced. To make this correction (see fig. 7a).
a) Loosen THUMB SCREW 110387 and remove CALIBRATION RING H472 then loosen SET SCREW 110288-2 in BASE ASSEMBLY H470.
b) Turn BEARING ASSEMBLY H485 with FMI supplied spanner wrench counterclockwise 1 full turn.
c) Turn ADJUSTMENT NUT H434 clockwise until its threads are completely seated on BASE H432.
d) Rotate BEARING ASS'Y H485 clockwise until PISTON ASS'Y H423 just touches back of logo (as described above) when rotated 360°.
e) Once properly adjusted rotate H485 counterclockwise 1/4 turn and tighten SET SCREW 110288-2. Replace CALIBRATION RING H472.
f) Turn ADJUSTMENT NUT back to its normal operating range and run pump.

23.1 RHB & RHV PISTON/CYLINDER RELATIONSHIP. To correct piston position on RHB & RHV pumps:
a) Loosen THUMB SCREW 110387 on CALIBRATION RING H472-1, rotate until 1/4" hole lines up with piston adjustment hole on BASE H432-1 (fig. 7b).
b) Looking into piston adjustment hole, rotate motor shaft until SET SCREW 110386-4 is visible, loosen set screw.
c) Turn ADJUSTMENT NUT H434 clockwise until threads are completely seated on BASE H432-1.
d) Position SPINDLE H424-1 forward until PISTON ASS'Y H423 is visible at back of logo as described above. Tighten set screw.
e) Check for smooth shaft rotation by turning motor shaft by hand. Repeat step (d) if required. To recalibrate see sec. 12.

24. PISTON SEAL SETTING. After installing new LIP SEALS H408 in pump head it is recommended that the SEALS be set (formed in place) by fluid pressures generated by pump action. To accomplish this:
a) Operate the pump spindle clockwise for 10 or 20 strokes at maximum setting, handling water (left to right mode facing the pump head with suction line blocked or pinched off). This will create a vacuum in the pump head, permitting atmospheric pressure to shape the outer seal member tightly around the piston.
b) Reverse the pumping direction (spindle direction reversed "CCW" on RH pumps) and partially block the suction line. This will generate pressure in the seal area of the pump head, causing the inner seals to form intimately around the piston.

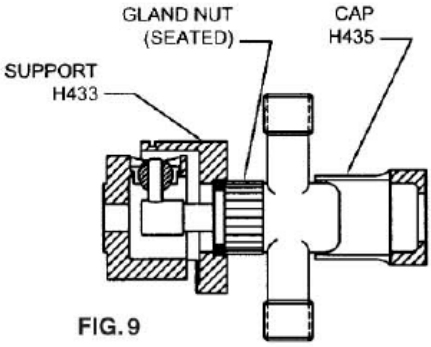


FIG. 9

FMI FLUID METERING, INC.
5 AERIAL WAY, SUITE 500, SYOSSET, NY 11791
(800) 223-3388 • (516) 922-6050 • FAX (516) 624-8261 • http://www.fmipump.com
ISO 9002

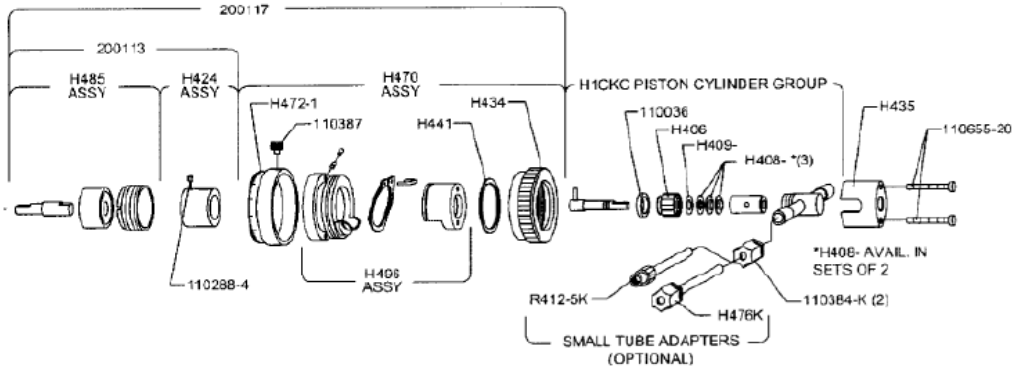


FIG 7c **MODELS RH00CKC, RHOCKC, RH1CKC** FIG. 7a

PARTS PRICE LIST - RH PUMP MODELS

PART NO.	DESCRIPTION
H406	GLAND NUT
H408-0A	LIP SEAL, RULON A, 3/16" PISTON (RH0)
H408-1A	LIP SEAL, RULON A, 1/4" PISTON (RH1)
H408-OOJ	LIP SEAL, RULON J, 1/8" PISTON (RH00)
H409-0	GLAND WASHER, TEFLON 3/16" PISTON (RH0)
H409-1	GLAND WASHER, TEFLON 1/4" PISTON (RH1)
H409-00	GLAND WASHER, TEFLON 1/8" PISTON (RH00)
H424	SPINDLE ASS'Y (RH)
H424-1	SPINDLE ASS'Y (RHB) (RHV)
H434	ADJUSTMENT NUT WITH DECAL
H435	CYLINDER CAP WITH DECAL
H441	SUPPORT RING
H470	BASE ASS'Y
H470-1	BASE ASS'Y (RHB) (RHV)
H472	CALIBRATION RING WITH DECAL
H472-1	CALIBRATION RING WITH DECAL (RHB) (RHV)
H474	ADAPTER PLATE, (MASTERFLEX)
H481-1	BRACKET, ADAPTER (Q)
H482	COUPLING
H482-1	COUPLING, DRIVE - (MASTERFLEX)
H485	BEARING ASS'Y
H496	CYLINDER SUPPORT ASSY (H470)
H498	CYLINDER SUPPORT ASSY (H470-1)

PART NO.	DESCRIPTION
110036	"O" RING
110049	WASHER, #8 INT LOCK
110132-3	SCREW, #8-32 x 3/16" PAN HEAD
110132-8	SCREW, #8-32 x 1/2" PAN HEAD
110132-18	SCREW, #8-32 x 1 1/8" PAN HEAD
110132-54	SCREW, #8-32 x 3 3/8" PAN HEAD
110230-6	SCREW, #8-32 x 3/8" PAN HEAD
110288-2	SET SCREW, #8-32 x 1/8" LONG
110288-4	SET SCREW, #8-32 x 1/4" LONG
110301	DRIVE PIN
110366	PISTON DRIVE PIN
110372	RETAINER, SPRING-RING
110384-K	FERRULE NUT, 1/4" O.D.
110384-T	FERRULE NUT, TEFLON

Please contact SciLog for Pricing and availability.

RH style heads in normal use should have their seals replaced on an annual basis. This is a service SciLog would prefer to do for you, allowing us to keep you informed as to the performance of the head, and when total replacement of the head may be needed. Please note the Maintenance form at the beginning of this manual.

Appendix “C”
Magnetic Gear Pump Head Installation and Maintenance

Magnetic Gear Pump Heads: General Information

The ChemTec MP-320 is equipped with a Magnetic Gear pump head and is recommended for metering applications requiring pulse-free flow. These are external gear type heads in which the spur gears rotate and intermesh inside the chamber, thereby creating a pressure differential between the inlet and outlet ports of the pump.

An inline check valve (SciLog p/n 400-536 or equivalent) must be installed on the discharge side of the pump head in order to avoid back-siphoning of solution between metering or dispensing cycles. The check valve must be above the solution reservoir level.

Only clean fluids, with out particulates or abrasives, should be dispensed or pumping capacity will decrease quickly. A gear replacement (Service) kit is available from SciLog.

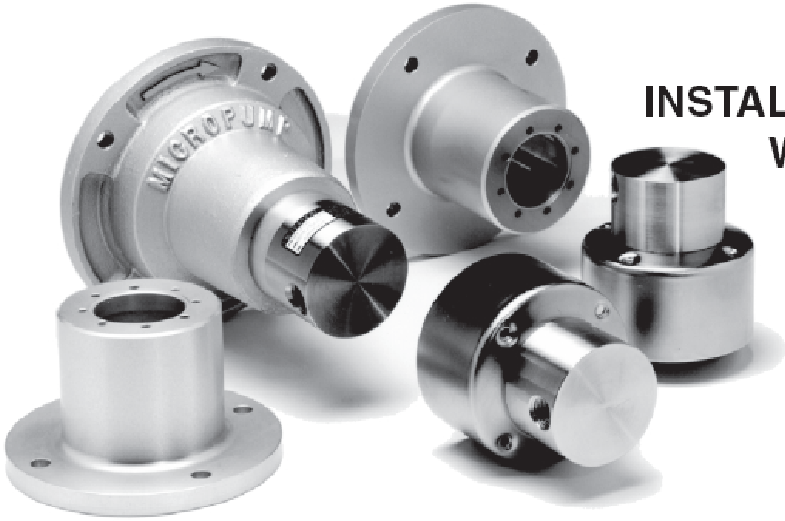
The rotating gears of a magnetic gear pump head generate significant shear, thus shear-sensitive solutions should not be metered/dispensed with this head. Use the Tandem Peristaltic pump head instead.

Magnetic decoupling of the head can occur when the torque limit of the driving magnet has been exceeded. Once this occurs, the driving magnet (the one attached to the motor shaft) turns by itself while the driven magnet (inside the pump head) remains motionless. Magnetic coupling can be restored by simply stopping the pump. The magnets will automatically re-align and re-couple. Decoupling is an inherent feature of magnetic couplings, do NOT indicate a pump failure, and should only occur when the magnet coupling torque limit has been exceeded. It often acts as a safety feature, preventing inadvertent pump / motor overloads.

Avoid metering of liquids of a viscosity greater than 500 cps as this will cause the de-coupling mentioned above. You will need to reduce the pump speed when metering fluids above 300 cps.

Magnetic gear heads have self-priming capabilities when they are new. The ability to self-prime is dependent on the fluid being pumped, your operating system conditions, and the pump model being used, and how long the pump has been in service. If the pump self-priming capability of the magnetic gear pump heads in use has diminished or stopped due to wear, flooding the head will get the fluid moving again as this capability is greatly increased when the gears are wet.

MICROPUMP



INSTALLATION, OPERATION AND WARRANTY INFORMATION

- 180 SERIES
- 120 SERIES
- 200 SERIES
- 220 SERIES
- 1330/1350
- 1601
- 5000

IDEX CORPORATION

DOC No: 7046 10/00

2

EC DECLARATION OF INCORPORATION

(In accordance with Annex II B of the Machinery Directive 89/392/EEC)

I, the undersigned Scott Hollister, of
MICROPUMP INC.
A Unit of IDEX Corporation
1402 NE 136th Avenue
Vancouver, WA 98684-0818
U.S.A.

CE

Declare that the pumps described in this document comply with the following EU directives:

EN809, EN 292 Part 1, EN 292 Part 2

and within the limits specified for the machinery, is in conformity with the essential health and safety requirements of the Machinery Directive 89/392/EEC and subsequent amending directives.

The machinery described in this certificate must not be put into service until the machinery in which it is incorporated has been declared in conformity with the provisions of the Machinery Directive and its amendments.

MANUFACTURER: **IMPORTER IN COUNTRY OF USE:**

Scott Hollister

(Signature) *(Signature)*

DOC No: 7046 10/00

PUBLISHED BY

MICROPUMP INC.
A Unit of IDEX Corporation
Fifth Edition October 2000

Every effort has been made to ensure that the information contained in this manual is accurate prior to printing. However, the products described in this manual are subject to continuous development and improvement and Micropump shall not be liable for any errors contained herein or for incidental or consequential damages in connection with the furnishing, performance or use of this manual.

SciLog
Intelligent BioProcessing Systems

4

INTRODUCTION

Your Micropump Pump....

represents years of fluid handling experience and we feel it is the finest product available of its type.

The pump you have purchased was designed and constructed to handle compatible, clean fluids within designated limits and conditions. Staying within performance limits and following the guidelines given in this manual will result in excellent performance and maximum pump life.

Should you have a question or a problem, technical assistance is available both in the USA and Europe. Micropump products are designed for easy field servicing with service kits and technical support available for all products.

The Purpose of this Guide....

is to provide information to enable suitably qualified technicians and fitters to install, operate and maintain the Micropump range of gear pumps and gear pump/motor combinations.

How to Use the Guide

You will have purchased a gear pump or gear pump/motor combination. This guide contains specific information for gear pumps and additional general information for gear pump/motor combinations. When installing or operating gear pump/motor combinations the instructions given in this guide should be read in conjuction with the instructions provided with the motor.

DOC No.: 7048 10/00

Contents

List of Abbreviations

The following abbreviations are used in this guide:

316SS	316 AISI Stainless Steel	PEEK	Polyetheretherketone
CG	Carbon Graphite	PPS	Polyphenylenesulfide
EPDM	Ethylene Propylene	PTFE	Polytetrafluoroethylene
NPSH	Net Positive Suction Head		

LIMITED WARRANTY

3

The products manufactured by Micropump Incorporated are warranted to be free from defects in workmanship and material at the time of shipment from the place of manufacture. Micropump will repair or replace, at its option any part of our product which fails to conform to this warranty for a period of one year from the date of manufacture, plus six months warehouse and transit period, or for a period of one year from the date of purchase by the first user of the product, whichever period expires first. In no event shall this period exceed 18 months from date of original invoice. Micropump's obligation under this warranty is limited to the repairs or replacement of defective equipment returned to us on an F.O.B. basis, providing that our examination discloses that such part or parts were defective at the time of sale.

The warranty described above is the exclusive Micropump warranty and is in lieu of all other warranties, expressed or implied, including any warranty of merchantability or fitness for a particular purpose or any warranty previously issued. We neither assume nor authorise any other person to assume for us any other liability in connection with the sale or use of our equipment.

No warranty of any kind is made or shall be imposed with respect to any pump or parts (1) which have not been properly installed and tested in operation, (2) which have been subject to misuse, negligence, acts of God or the elements, or any other form of casualty, or (3) which have been repaired or altered outside of Micropump's plant so as, in our judgment, to affect performance or reliability.

The parties agree that the buyer's sole and exclusive remedy against Micropump shall be for the repair or replacement of defective parts under the conditions stated above. The buyer agrees that no other remedy, including but not limited to incidental or consequential damages for lost profits, lost sales, loss of use, injury to person or property, or any other incidental or consequential loss shall be available to it.

This warranty shall not apply to prototype pumps, experimental pumps, special pumps, or brush-type electric motors. Our warranty position of the aforementioned equipment is available on request.

The adjustment or replacement of defective parts made under this warranty will not extend the original warranty period.

DOC No: 7048 10/00

GENERAL

5

Safety

The following are used throughout this guide to indicate procedures that, if not followed correctly, may result in injury to personnel or damage to equipment.

Warnings are used to alert the reader to a procedure or practice, which if not followed correctly, could result in personal injury.

Cautions are used to alert the reader to a procedure or practice, which if not followed correctly, could result in damage to the gear pump or ancillary equipment.

Notes are used to highlight important information that may assist the reader in carrying out a procedure or in understanding the text.

6

LIMITS OF USE

Limits of Use

To achieve optimum performance and safe operation Micropump gear pumps must be operated within the limits given for each model in the Technical Specification tables. Operation outside these limits is not recommended and may result in damage to the gear pump and/or ancillary equipment.

Temperature. Operating the pump beyond the maximum operating temperature given in the technical specification is not recommended and may result in damage to the pump.

Dust and Airborne Contamination. Pump performance is not affected providing the installation instructions given are followed. Reference should always be made to the installation and operating instructions for the motor under such conditions.

Corrosive Liquids. Corrosive liquids may eventually produce leak paths around the sealing surfaces of the pump. The pump should be inspected for leaks on a regular basis.

Flooding and Water Immersion. The pumps covered by this guide are not designed to operate immersed in water. Reference should always be made to the installation and operating instructions for the motor under such conditions.

High Humidity. When pumping cold liquids ensure that condensation does not present a safety hazard. Condensation on the external surfaces of the magnet cup may result in motor seizure. Reference should always be made to the installation and operating instructions for the motor under such conditions.

High Pressure Fluid Ejection. Providing the pump is operated within its technical specification the sealing system will prevent high pressure fluid ejection.

Unpacking and Storage

Before installing the gear pump ensure all transit packaging has been removed. Remove the blanks from the inlet and outlet ports. If the gear pump is to be stored prior to installation re-pack the gear pump in its original packing, refit the blanks to the ports and store in a dry, covered environment.

TECHNICAL SPECIFICATION 180 SERIES

7

MODEL No.	180	181	182	183	184	185	186	187	188	1800	1830	1840
FLOW RATE @ 3450rpm (ml/min)	145	145	290	290	145	290	60	60	320	320	320	320
MAX. SPEED (rpm)	8000	8000	8000	8000	8000	8000	8000	8000	8000	10000	10000	10000
MAX. SYSTEM PRESSURE (bar)	20	20	20	20	20	20	20	20	20	20	20	20
MAX. DIFFERENTIAL PRESSURE FOR CONTINUOUS DUTY (bar)	2.75	2.75	2.75	2.75	2.75	2.75	1.4	1.4	1.4	3.4	3.4	3.4
MAX. DIFFERENTIAL PRESSURE FOR INTERMITTENT DUTY (bar)	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	5.5	5.5	5.5
MAX. DIFFERENTIAL PRESSURE (bar) See Note 1	9.7	24.8	4.5	20.7	24.8	20.7	27.6	27.6	11	4.5	20.7	20.7
DE-COUPLING TORQUE (mN/m)	21	78	21	78	78	78	78	78	21	21	78	78
VISCOSITY RANGE (Centipoise)	Up to 100	Up to 100	Up to 100	Up to 100	Up to 100	Up to 100	Up to 100	Up to 100	Up to 100	Up to 100	Up to 100	Up to 100
TEMPERATURE RANGE	-46 to 122°C	-46 to 122°C	-46 to 122°C	-46 to 122°C	-46 to 122°C	-46 to 122°C	-46 to 122°C	-46 to 122°C	-46 to 122°C	-46 to 122°C	-46 to 122°C	-46 to 122°C
WETTED MATERIALS												
Pump Body:	316SS	316SS	316SS	316SS	316SS	316SS	316SS	316SS	316SS	316SS	316SS	316SS
Gears/Bushings:	CG	CG	CG	CG	CG	CG	CG	CG	CG	PPS	PPS	PPS
Seals:	PTFE	PTFE	PTFE	PTFE	PTFE	PTFE	PTFE	PTFE	PTFE	PTFE	PTFE	PTFE
Shafts:	316SS	316SS	316SS	316SS	316SS	316SS	316SS	316SS	316SS	316SS	316SS	316SS
Driven Magnet:	316SS & PTFE	316SS & PTFE	316SS & PTFE	316SS & PTFE	316SS & PTFE	316SS & PTFE	316SS & PTFE	316SS & PTFE	316SS & PTFE	316SS & PPS	316SS & PPS	316SS & PPS
BYPASS VALVE	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
NOISE LEVEL dB(A)	<70	<70	<70	<70	<70	<70	<70	<70	<70	<70	<70	<70

Note 1: These pressures are the maximum the pump will generate if the pump outlet becomes blocked.

8

TECHNICAL SPECIFICATION 120 SERIES

MODEL No.	114	020	120	122	030	130	132	040	140	142	050	150	152
FLOW RATE @ 3450rpm (ml/min)	9500	1100	2240	3300	1100	2240	3300	1100	2240	3300	1100	2240	3300
MAX. SPEED (rpm)	4000	10000	10000	8000	10000	10000	8000	10000	10000	8000	10000	10000	8000
MAX. SYSTEM PRESSURE (bar)	20 or 92 (See Note 2)	20	20	20	20	20	20	20	20	20	20	20	20
MAX. DIFFERENTIAL PRESSURE FOR CONTINUOUS DUTY (bar)	3.4	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
MAX. DIFFERENTIAL PRESSURE FOR INTERMITTENT DUTY (bar)	4.1	6	6	5.5	6	6	5.5	7.5	7.5	5.5	7.5	7.5	5.5
MAX. DIFFERENTIAL PRESSURE (bar) See Note 1	5.9	6.2	6.2	6.2	6.2	6.2	6.2	19.3	9.8	7.2	19.3	9.8	7.2
DE-COUPLING TORQUE (mN/m)	706	134	134	134	134	134	134	78	134	134	134	134	134
VISCOSITY RANGE (Centipoise)	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
TEMPERATURE RANGE See Note 3	-46 to 54°C	-46 to 54°C	-46 to 54°C	-46 to 54°C	-46 to 122°C	-46 to 122°C	-46 to 122°C	-46 to 54°C	-46 to 54°C	-46 to 54°C	-46 to 122°C	-46 to 122°C	-46 to 122°C
WETTED MATERIALS													
Pump Body:	316SS	316SS	316SS	316SS	316SS	316SS	316SS	316SS	316SS	316SS	316SS	316SS	316SS
Gears/Bushings:	PTFE	PTFE	PTFE	PTFE	PPS	PPS	PPS	PTFE	PTFE	PTFE	PPS	PPS	PPS
Seals:	PTFE	PTFE	PTFE	PTFE	PTFE	PTFE	PTFE	PTFE	PTFE	PTFE	PTFE	PTFE	PTFE
Shafts:	316SS	316SS	316SS	316SS	316SS	316SS	316SS	316SS	316SS	316SS	316SS	316SS	316SS
Driven Magnet:	316SS & PTFE	316SS & PTFE	316SS & PTFE	316SS & PTFE	316SS & PTFE	316SS & PTFE	316SS & PTFE	316SS & PTFE	316SS & PTFE	316SS & PTFE	316SS & PTFE	316SS & PTFE	316SS & PTFE
BYPASS VALVE	NO	YES	YES	YES	YES	YES	YES	NO	NO	NO	NO	NO	NO
NOISE LEVEL dB(A)	<70	<70	<70	<70	<70	<70	<70	<70	<70	<70	<70	<70	<70

Note 1: These pressures are the maximum the pump will generate if the pump outlet becomes blocked.

Note 2: This model is supplied in two configurations. Each configuration has a different maximum system pressure. Models with part number 80943 have a maximum system pressure of 20 bar. Models with part numbers 81427 and 81744 have a maximum system pressure of 92 bar.

Note 3: For pumps with PTFE gears a temperature of 54°C is the maximum temperature with standard seals. Alternative seals can be fitted which will give a maximum temperature of 98°C with the exception of the 114 which has a maximum temperature of 54°C. Consult Micropump or an authorised distributor.

DOC No: 7048 10/00

TECHNICAL SPECIFICATION 200 AND 220 SERIES

9

MODEL No.	200.15	200.35	201	219	220	221	223
FLOW RATE @ 3450rpm (ml/min)	900	2050	3950	3000	6400	11000	11000
MAX. SPEED (rpm)	10000	10000	8000	8000	6000	4000	4000
MAX. SYSTEM PRESSURE (bar)	20	20	20	103	68	68	103
MAX. DIFFERENTIAL PRESSURE FOR CONTINUOUS DUTY (bar)	5	5	3.5	4.1	4.1	4.1	4.1
MAX. DIFFERENTIAL PRESSURE FOR INTERMITTENT DUTY (bar)	5.5	5.5	3.5	10.3	8.3	4.5	4.5
MAX. DIFFERENTIAL PRESSURE (bar) See Note 1	11	7.5	4.5	11	10.3	5.2	7
DE-COUPLING TORQUE (mN/m)	162	162	162	388	692	692	692
VISCOSITY RANGE (Centipoise)	100	100	100	1500	1500	1500	1500
TEMPERATURE RANGE	-46 to 122°C	-46 to 122°C	-46 to 122°C	-46 to 122°C	-46 to 122°C	-46 to 122°C	-46 to 122°C
WETTED MATERIALS							
Pump Body:	316SS	316SS	316SS	316SS	316SS	316SS	316SS
Gears/Bushings:	PPS	PPS	PPS	PPS	PPS	PPS	PPS
Seals:	VITON®	VITON® or EDPM	VITON®	VITON®	VITON®	VITON®	NEOPRENE
Shafts:	316SS	316SS	316SS	316SS	316SS	316SS	316SS
Driven Magnet:	316SS & PPS	316SS & PPS	316SS & PPS	316SS & PPS	316SS & PPS	316SS & PPS	316SS & PPS
BYPASS VALVE	OPTIONAL	OPTIONAL	OPTIONAL	NO	NO	NO	NO
NOISE LEVEL dB(A)	<70	<70	<70	<70	<70	<70	<70

Note 1: These pressures are the maximum the pump will generate if the pump outlet becomes blocked.

DOC No: 7046 10/00

10

TECHNICAL SPECIFICATION 1330/1350/1601/5000

MODEL No.	1330	1350	1601	5000
FLOW RATE @ 3450rpm (ml/min)	2300	2300	360	20000
MAX. SPEED (rpm)	5000	5000	8000	4000
MAX. SYSTEM PRESSURE (bar)	13.8	13.8	5.2	20
MAX. DIFFERENTIAL PRESSURE FOR CONTINUOUS DUTY (bar)	3.5	3.5	2.75	2
MAX. DIFFERENTIAL PRESSURE FOR INTERMITTENT DUTY (bar)	3.5	3.5	2.75	3
MAX. DIFFERENTIAL PRESSURE (bar) See Note 1	5.5	5.5	4.5	3.5
DE-COUPLING TORQUE (mN/m)	134	134	21	680
VISCOSITY RANGE (Centipoise)	100	100	100	1500
TEMPERATURE RANGE	-45 to 65°C	-45 to 65°C	-45 to 65°C	-46 to 122°C
WETTED MATERIALS				
Pump Body:	316SS & PPS	316SS & PPS	PPS	316SS
Gears:	PPS	PPS	PPS	PTFE or PEEK
Bushings:	PPS	PPS	PPS	RULON® or PEEK
Seals:	VITON®	VITON®	EPDM	PTFE or VITON®
Shafts:	316SS	316SS	316SS	316SS
Driven Magnet:	316SS & PPS	316SS & PPS	316SS & PPS	316SS & PPS
BYPASS VALVE	YES	NO	NO	NO
NOISE LEVEL dB(A)	<70	<70	<70	<70

Note 1: These pressures are the maximum the pump will generate if the pump outlet becomes blocked.

DOC No: 7046 10/00

DESCRIPTION

11

Description

The pump comprises a sealed unit containing the pumping parts which are connected to a driven magnet. The magnetic cup separates the pumped liquid from the atmosphere and is attached to the pump body. Elastomer seals prevent leakage. The driving magnet, which is attached to a motor shaft, encircles the magnetic cup.

180 Series Pumps are suction shoe gear pumps. Each pump is manufactured from 316 stainless steel and is fitted with PTFE seals and carbon graphite gears and suction shoes. 1800, 1830 and 1840 pumps are fitted with PPS gears and suction shoes.

200 Series Pumps are suction shoe gear pumps. Each pump is manufactured from 316 stainless steel and is fitted with Viton® seals and PPS gears and suction shoes.

120 Series Pumps are conventional cavity style gear pumps. Each pump is manufactured from 316 stainless steel and is fitted with PTFE seals and gears. Model 130 and 150 pumps are fitted with PPS gears.

1330/1350/1601 Pumps are conventional cavity style gear pumps. Each pump is manufactured from PPS and is fitted with PPS gears. 1330/1350 models are fitted with Viton® seals. 1601 models are fitted with EPDM seals.

5000 Pumps are conventional cavity gear pumps. Each pump is manufactured from 316 stainless steel and is fitted with either PTFE seals and gears or PEEK gears and Viton® seals.

Function

The driven magnet is connected to the pumping parts and is sealed in the magnet cup. The driving magnet, which is connected to the motor, encircles this cup. The magnets align pole-to-pole and rotate together with no slippage until the decoupling limit is exceeded. Rotation of the pumping elements produces flow.

Magnet Decoupling

Magnetic decoupling occurs when the load on the pump exceeds the coupling torque between the magnets. The magnets are forced out of pole-to-pole alignment and are decoupled. When decoupling occurs, the driving magnet speed increases to motor no-load speed while the driven magnet and pumping parts remain motionless. To recouple the magnets the motor must be stopped, allowing the magnets to re-align and then restarted.

NOTE

Decoupling is an inherent feature of magnetic couplings and DOES NOT indicate a pump failure. Decoupling should only occur when the magnet decoupling torque has been exceeded. Decoupling can be a safety feature, preventing inadvertent pump/motor overloads.

The decoupling torque can vary with different fluids, temperatures, system conditions and width of driving magnet. The decoupling torques given in the Technical Specification tables are for pumping clean water at 21°C.

DOC No: 7046 10/00

INSTALLATION

12

Installation

Pump Location. The following should be observed when selecting the pump location:

- The pump should be located with the inlet below or as close as possible to the fluid level of the fluid supply. The pump can be mounted in any position.
- Ensure that there is adequate space for operation, inspection and maintenance.
- The foundation must be capable of supporting the combined weight of the pump and motor and provide a rigid support.

Installation in Explosive and Fire Danger Zones.

WARNING

Ensure the motor is suitable for area classification.

WARNING

Ensure that the pumphead does not exceed flash point temperature of area if pumping hot liquids.

WARNING

Ensure that the pump does not run dry for extended periods.

DOC No: 7046 10/00

Space Requirements. Refer to the illustrations on pages 21-22 for overall dimensions and weights of the pumps covered by this guide.

Pipework. The following should be observed when connecting pipework.

- Pipes connected to the pump should be level or slope down towards the pump.
- Ensure that no part of the pipe extends below the level of the pump suction port.
- Ensure all pipes and fittings are of the correct size for the pump being installed. Refer to the following table.

NOTE

Restrictions in the inlet and discharge lines may cause a loss of pump performance. A restriction can be a valve, small bore tubing, long lengths of tubing or sharp turns/elbows in the line. Limit these restrictions wherever possible.

PUMP MODEL No.	PORT SIZE	MIN. RECOMMENDED TUBING I.D.
180 Series	1/8" NPT	6.5mm (1/4")
040, 120, 130, 122	1/8" NPT	6.5mm (1/4")
114	1/4" NPT	10mm (3/8")
200, 201	1/8" NPT	6.5mm (1/4")
220, 221	3/8" NPT	12.5mm (1/2")
1330/1350	1/8" NPT	6.5mm (1/4")
1601	1/4" UNF	6.5mm (1/4")
5000	1/2" NPT	12.5mm (1/2")

INSTALLATION

13

Filtration.

The pump can be damaged if the fluid being pumped has suspended solids that are abrasive. Always install a suitable filter or strainer when these fluids are being pumped.

For open systems the filter must be installed on the inlet side of the pump. For closed loop systems the filter can be installed on the inlet or discharge side.

Recommended filter specifications for the pumps covered by this guide are given below.

All strainers and filters should have large surface areas to prevent excessive pressure drop.

PUMP SERIES	FILTER TYPE/SIZE
180/1601	5 MICRON, [<0.14 bar (2 psi) pressure drop] CANNISTER or FINE MESH style
120 1330/1350/5000	40 MICRON, soft particles [<0.27 bar (4 psi) pressure drop] 5 MICRON, hard particles [<0.27 bar (4 psi) bar pressure drop] CANNISTER style
200/210/220	40 MICRON, soft particles [<0.14 bar (2 psi) bar pressure drop] 5 MICRON, hard particles [<0.14 bar (2 psi) pressure drop] CANNISTER style

Mounting Plates and Adapters

If you have purchased a pump/motor combination this will be assembled ready for installation.

If you have purchased a pump without a motor you may require an NEMA 56C or IEC/ISO adapter. IEC/ISO adapters are supplied in frame sizes 56, 63 and 71.

Models 114, 219, 220, 221, 223 and 5000 are supplied in ready to mount form in either 56C or IEC/ISO format (frame size 63 and 71).

Models 020, 030, 040, 050, 120, 122, 130, 132, 140, 142, 150, 152, 1840, 184, 185, 187, 200 and 201 couple directly to Micropump 56C or IEC/ISO adapters. Refer to the instructions supplied with the adapter kit for installation details.

Models 180, 181, 182, 183, 186, 188, 1800, 1830, 1300/1350 and 1601 are designed for use with small motors and do not accept 56C or IEC/ISO motors. These models are supplied with a suitable motor mounting bracket. Refer to the instructions supplied with the motor mounting bracket for installation details.

If a non-Micropump mount/adapter is used it must comply with the requirements of EN 809.

Mounting screws are provided with Micropump supplied motors. Mounting screws are not provided with gear pumps.

14

INSTALLATION

Fitting the Pump/Motor to the Installation. It is recommended that the pipe fittings are connected to the pump before the pump/motor is fitted into the installation. The following should be observed when connecting pipe fittings:

- Pipe sealing compound or PTFE tape should be applied to the threads to prevent leakage.
- Apply sealant or tape sparingly to prevent a build up of excess material which may dislodge and clog the pump. Two wraps of PTFE tape are usually sufficient.
- Secure the pump in a vice (use pads to protect the pump body) and support the motor when installing fittings.

Do not overtighten fittings. Refer to the manufacturers installation instructions for torque values .

Ensure all piping is clean and flushed out prior to connection to the pump. Do not force piping into position as this will place unnecessary strain on the pump.

Ensure that inlet and discharge pipes are connected correctly in relation to the direction of flow arrow marked on the pump.

Piping should be installed according to the following guidelines:

- Design piping runs to minimise friction losses. Restrictions in the inlet and discharge lines may cause a loss in performance.
- Piping that handles hot liquid requires installation of expansion loops/joints to prevent misalignment from linear expansion.
- Never size suction piping diameter smaller than the pump suction port.
- Ensure all joints are airtight.
- Separate suction lines are recommended when more than one pump is operating from the same medium source.

If in doubt refer to the guidelines for piping given in the "Hydraulic Institute Standards".

Secure the pump/motor to the installation using suitable fixing bolts. Connect the inlet and discharge pipework to the pump.

INSTALLATION

15

Electrical Connection. Refer to the installation instructions supplied with the motor for connection details.

Electrical installation must be carried out by qualified personnel who are conversant with local electricity installation regulations.

Before starting any electrical installation work ensure that the main electrical supply is adequately isolated.

Ensure that the voltage and frequency of the supply are correct for the motor being connected.

When using DC motors they must be connected to a class II power supply.

The pump may be electrically isolated from the motor depending on the mounting configuration. Some installations may need an earthing connection on the pumphead.

Pumping flammable fluids without a proper earthing connection may cause spontaneous ignition.

Compressed Air Connection. Refer to the installation instructions supplied with the motor for connection details.

Compressed air connections must be carried out by qualified personnel who are coversant with the hazards associated with high pressure air supplies.

Ensure that the compressed air supply is suitable for the type of motor being used.

DOC No: 7046 10/00

16

OPERATION

Operation

Start-up Procedure. Before starting the pump ensure that any valves in the inlet or discharge lines are open and that any inlet filters are clean and free from obstruction.

Starting or running the pump with the discharge valve closed will result in overloading of the drive motor and overpressure in the discharge pipe.

Once started the pump should prime if it has not already been filled with fluid. If the pump fails to prime, stop the pump and fill the pumphead with liquid.

Post Start-up Checks. Once the pump has started carry out the following checks:

Check that the pump is rotating in the correct direction. This should be clockwise when viewing the drive shaft of the drive unit. If the direction of rotation is incorrect check the motor electrical connections.

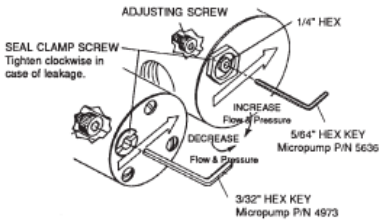
Flow rate should always be adjusted by the valve fitted in the discharge line. Ensure that overpressure does not occur in the discharge pipe. NEVER throttle flow by the inlet valve.

DOC No: 7046 10/00

- Check that the pump and motor operate smoothly and are free from vibration.
- Check the inlet and discharge fittings are free from leaks.

Shut-down Procedure. Switch off the drive motor and check that the unit runs down in a steady manner. Close the inlet and discharge valves. Drain the pump if it is to be shut-down for long periods or installed in areas where the liquid may freeze.

Bypass Valve Adjustment. The bypass valve is an internal relief valve that permits recirculation of the working fluid when the pre-set pressure is reached. The bypass can be activated from 0.7 bar (10psi) to the maximum differential pressure of the pump. The bypass can be adjusted in situation while the pump is operating by rotating the adjusting screw with the hexagon key provided. Turn the screw clockwise to increase pump pre-set pressure and anticlockwise to decrease pump pre-set pressure.



CAUTION

The pump internally re-circulates bypass fluid and heat can be produced as a result. Increasing the amount of fluid that is re-circulated through the bypass will increase the heat produced. It is possible that at full bypass the fluid temperature will exceed the operating temperature of the pump. Micropump recommend that pumps are not run continuously at full bypass.

How to Recognise Magnet De-coupling. Magnet decoupling occurs when the load on the pump exceeds the coupling torque between the magnets. The magnets are forced out of pole-to-pole alignment and are decoupled. When decoupling occurs , the driving magnet speed increases to motor no-load speed while the driven magnet and pumping parts remain motionless.

NOTE

Decoupling is an inherent feature of magnetic couplings and DOES NOT indicate a pump failure. Decoupling should only occur when the magnet decoupling torque has been exceeded. Decoupling can be a safety feature, preventing inadvertent pump/motor overloads.

Causes of Magnet De-coupling. Due to the quiet operation of magnetic pumps it is not always possible to detect, without disassembly of the pump, when the magnet coupling and pumping parts are operating incorrectly. It is therefore important to be able to recognise possible causes of magnet de-coupling:

- Blockage or restriction in the discharge side of the system
- Discharge pressure exceeds decouple point
- Fluid viscosity too high
- Foreign particles jamming pumping parts
- Binding or stuck pumping parts - this may occur between pumping cycles as a result of dried residue of the fluid being pumped. Drain and flush the pump to remove the residue.

Magnet Re-coupling. Before re-coupling ensure that the cause of the de-coupling has been identified and rectified. To recouple the magnets the motor must be stopped, allowing the magnets to re-align, and then restarted.

Draining. The pump should only require draining prior to disassembly for service, changing the type of liquid being pumped or to prevent frozen liquid damage to the pump

WARNING

The pump cannot be drained completely, a certain amount of liquid will remain in the magnet cup area. Ensure that the pump is either flushed with a suitable flushing agent or precautions are taken against the effect of any remaining liquid during servicing. When the pump has been handling flammable, toxic or hazardous fluid, the pump internals must be properly decontaminated by suitably qualified personnel. The Material Safety Data Sheet for the pumped liquid must be referred to for correct procedures and precautions to be followed when handling the liquid.

Dry Running. Dry running for short intervals (i.e. when dry lifting to prime the pump) may not affect pump performance.

CAUTION

Extended periods of dry running may result in permanent damage to the pump.

Mixed Phase. Micropump gear pumps can handle mixed phase (gas/fluid) pumping.

Reverse Pressure. Pressure loaded suction shoe pumps (Series 180, 200, 220) cannot operate conventionally under reverse pressure conditions. This occurs when the fluid pressure coming into the pump is greater than the fluid on the discharge side. Contact your Micropump distributor for information on reverse pressure installations.

MAINTENANCE AND FAULT ISOLATION

19

Maintenance

Micropump magnetic drive gear pumps are designed to be maintenance free and, apart from bypass models, require no adjustments. To ensure the pump retains optimum performance maintain the fluid circuit to keep filters clean and prevent abrasive solids from passing through the pump.

Like all pumps Micropump gear pumps contain components that will wear over a period of time. This will be noticeable by a gradual deterioration in performance and you should contact your Micropump distributor for a service kit. Each service kit contains full fitting and service instructions.

Fault Isolation.

If the pump does not meet its design performance or fails to operate correctly refer to the following tables for assistance in identifying the cause and remedy:

PUMP PRODUCES NO LIQUID AT START UP

CAUSE	REMEDY
Suction valve closed. Discharge valve closed.	Open suction valve. Open discharge valve.
Pump does not come up to speed, magnets de-couple.	Shut off the motor. Check the motor is running. Ensure inlet and outlet valves are open.

PUMP DOES NOT SUCTION LIFT OR SELF PRIME

CAUSE	REMEDY
Suction pipe is not properly sealed and the pump is pulling in air.	Check suction pipe and fittings are airtight.
Viscosity of liquid is too high or too thin causing loss of self-priming capability.	Install foot valve at the bottom of the suction line, fill suction line and pump with liquid before restart. Modify pipe layout.

PUMP SEIZES IMMEDIATELY AFTER START-UP

CAUSE	REMEDY
Solids are present in the pump.	Clean tank and piping system. Replace any damaged parts before reassembly

PUMP IS NOISY AND VIBRATES AFTER START-UP

CAUSE	REMEDY
Magnet coupling out of alignment. Signs of rubbing may be present on magnet cup.	Check alignment. Ensure adapter/mount is of the correct type and is not damaged or distorted. Use only Micropump adapter/mounts.
Mounting base not rigid.	Ensure the base is adequately supported, particularly in the area of the motor attaching points. Ensure attachment bolts are of the correct size and tightened sufficiently.
Pump cavitates; NPSH available < NPSH required.	Increase NPSH available.

DOC No: 7046 10/00

PUMP DOES NOT OBTAIN RATED FLOW OR PRESSURE AT START UP

CAUSE	REMEDY
Suction line valve is not fully open.	Open suction valve.
Suction line strainer or filter is blocked.	Clean.
Pump rotates in wrong direction.	Check motor electrical connections (refer to connection details supplied with motor).
Suction pipe is not properly sealed and the pump is pulling in air.	Check suction pipe and fittings are airtight.
Differential head of the system is higher than specified.	If differential head cannot be reduced, a higher pressure pump is required.
Viscosity is higher than pump specification.	Contact your Micropump application engineer.
Pump cavitates; NPSH available < NPSH required.	Increase NPSH available.

MOTOR IS OVERLOADED

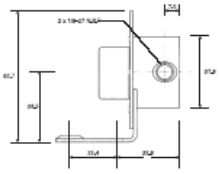
CAUSE	REMEDY
Differential head is higher than specification, discharge valve is fully open. Pump operates with reduced capacity and increased power consumption.	If capacity is more than required, install additional bypass line from discharge to suction. Adjust the capacity and differential head with a throttle valve in the bypass line.
Density or viscosity is higher than pump specification.	Contact your Micropump application engineer.

DOC No: 7046 10/00

WEIGHTS AND DIMENSIONS

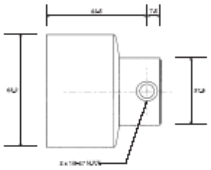
Weights and Dimensions

All dimensions in mm.

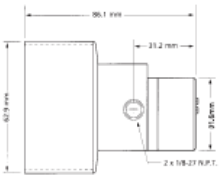


Model 181, 183, 186, 1830
Weight = 0.27kg

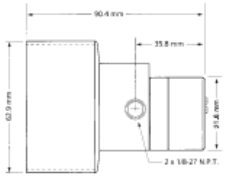
NOTE: Bracket is supplied with some motor assemblies and is shown here for dimensional purposes only.



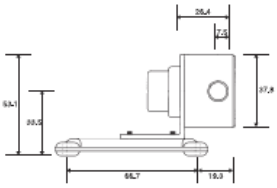
Model 184, 185, 187, 1840
Weight = 0.31kg



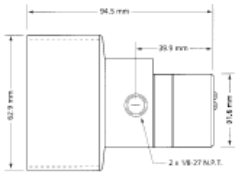
Models 020, 030, 040, 050
Weight = 0.43kg



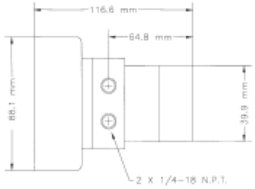
Models 120, 130, 140, 150
Weight = 0.46kg



Model 180, 182, 188, 1800
Weight = 0.24kg



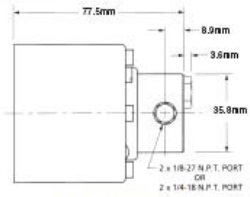
Models 122, 132, 142, 152
Weight = 0.47kg



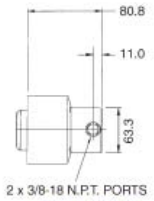
Model 114
Weight = 1.63kg

DOC No: 7046 10/00

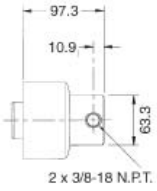
WEIGHTS AND DIMENSIONS



Models 200, 201
Weight = 0.36kg

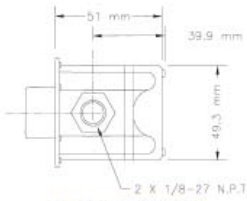


Model 219
Weight = 1.63kg

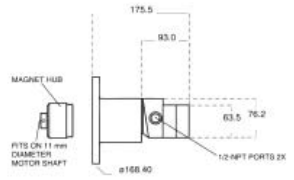


Models 220, 221, 223
Weight = 1.63kg

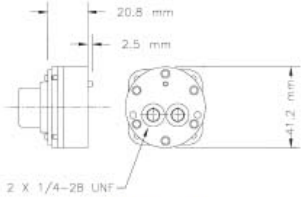
DOC No: 7046 10/00



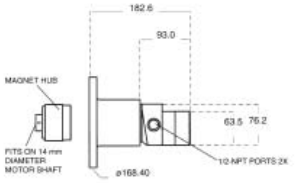
Models 1300/1350
Weight = 0.25kg



Model 5000 on IEC/ISO 63 Adapter
Weight = 3.9Kg



Model 1601
Weight = 0.06kg



Model 5000 on IEC/ISO 71 Adapter
Weight = 3.9Kg